F l tor ı Cl ef IRVING S WRIGHT M D
Consulting Ed to RICHARD H ORR M D

Dıverticulıtis

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GRUNE & STRATTON • 1960



381 Park Avenue South, New York 16, New York
Library of Congress Catalog Card Number 60-[illegible]31
Printed and bound in the United States of America [illegible]

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Preface

It is customary at the end of a preface for the author or authors to acknowledge their indebtedness to all those who assisted in the preparation of their book Contrary to this custom I would like to acknowledge at once that Dr Jordan was asked to write this monograph Fortunately she had written a substantial part of it in which her personal views were presented before her untimely illness intervened It was my rare privilege to be closely associated with Dr Jordan for some years and to collaborate with her when it became evident that she could not finish this undertaking Since then I have attempted to complete the volume her last contribution to medicine in accordance with her desires I can only hope that the final product will meet with the approval of those who may choose to read it

It was her opinion that by a critical review of the history of diverticulosis and diverticulitis a more complete understanding of this disease would be achieved This review is followed by a discussion of the subject based on an unusually broad experience with colon disorders

The diagnosis and treatment of diverticulosis and diverticulitis are discussed at some length with appropriate recognition given to their complications The indications for surgical intervention are presented but details of surgical technic are omitted because it was believed they would be more appropriately covered in the surgical literature

I want to acknowledge for Dr Jordan and myself our grateful appreciation to Dr Richard B Cattell and Dr Samuel F Marshall of the Clinic staff who reviewed the final draft and offered constructive criticism to the Editorial and Photographic Departments for their helpful cooperation and to Dr Melvin King who aided in compiling the bibliography We are also indebted to the publishers

for their constructive suggestions and assistance in handling many of the details involved

RUSSELL S BOLES JR M D

August 1960

1 *Nomenclature*

The word *diverticulum* was first used by Cruveilhier[3] in 1849 to describe the small outpouching from the wall of a hollow organ which is now generally recognized as present singly or in numbers in the conditions known as diverticulosis and diverticulitis

The Latin word *diverticulum* literally means a small diversion from the normal path Perhaps no other medical word is so often used incorrectly in its suffix—the correct singular being the neuter *um* and the plural *a* whereas not infrequently the neuter plural is mistakenly used as a feminine singular and of it a feminine plural *diverticulae* is falsely contrived

From the word *diverticulum* the derivative *diverticulosis* is used to describe the presence of such outpouchings and when there is inflammation in them the suffix *itis* indicating inflammation and infection replaces *osis* and forms the word *diverticulitis* When such inflammation involves the structures surrounding the pouches it is called *peridiverticulitis*

Where the words *diverticulosis* and *diverticulitis* are used without localizing the site of the abnormalities they are usually understood as referring to the colon where diverticula are most frequently found

However diverticula are found though much less frequently in the esophagus as well as all parts of the gastrointestinal tract and in the urinary bladder and gallbladder

2 Historical Review

Like the history of medical knowledge of many other diseases, that of diverticulosis and of diverticulitis has considerable interest in that it shows the changing trends of thought in the past 50 years with regard to all aspects of these conditions. It seemed to the authors, therefore, that a review of some of the literature of more than a half century would throw an interesting light upon the whole subject of diverticulitis. There follows, therefore, in chronological series abstracts of some of the literature on this subject.

The etiology of the formation of the diverticulum has aroused much discussion, especially in the early part of this century. Cruveilhier's pathologic description of this intestinal defect had been *regarded with little interest until Graser*[50] in *1899* wrote on a *false* diverticulum which he regarded as a hernial protrusion at a weak spot in the muscular layer of the colon produced by the entrance or exit of a blood vessel. He thought that such a protrusion constituting a diverticulum burrowed along the blood vessel sheath and was especially likely to occur if there were any obstructions to a free return of blood through inferior mesenteric veins as in valvular heart disease. This paper of Graser aroused interest in this condition to which very little attention had been paid since Cruveilhier's description 50 years previously.

1904

Beer[10] in a paper entitled "Some Pathological and Clinical Aspects of Acquired (False) Diverticula of the Intestine" pointed out that the studies on the dead colon done by previous investigators (Klebs, Heschl, Hanau, Good, Hansemann, Fischer and Graser[45]) did not necessarily apply to the living colon, and Beer particularly refuted the theory that weakness at the mesenteric border and at the point of entrance and exit of blood vessels was the basic reason for hernial protrusion. He quoted Chlumsky[77] who had performed

studies in the intestine of the living dog distending it to the point of rupture which was invariably on the nonmesenteric side of the gut a contrast to the studies on the intestine 10 hours after death when rupture occurred along the mesenteric border He also referred to Sudsuki s work which in refutation of Graser s theory showed that only 6 of 15 cases of acquired diverticulitis showed a congestive condition Sudsuki[103] had still held however to the theory that diminished resistance at the points of entrance of blood vessels was responsible for the formation of diverticula Beer however proposed the theory that old age and constipation best accounted for the formation of diverticula which occurred both on the nonmesenteric side of the gut where there are no points of entrance of blood vessels as well as along the mesenteric border

1906

Moynihan[81, 8] directed attention as did Graser to the difficulty in differentiating diverticulitis from carcinoma and reported 6 cases on which he had operated with a diagnosis of malignant disease before or at operation and in which subsequent histologic examinations showed false diverticula associated with inflammation

In that same year Gordinier and Sampson[48] suggested that diverticula be looked for more frequently and that acquired diverticula of the small intestine occurred much more frequently than autopsy records showed and undoubtedly caused minor symptoms He found them usually multiple arising at the site of vessel entry into the intestinal wall and sometimes involving the whole length of the small intestine whereas acquired diverticula of the colon were most frequently found in the sigmoid arising from any portion of the circumference of the bowel and of more clinical significance than those of the small bowel

1907

The question of so called true and false diverticula was discussed by W J Mayo[76] and others who described the commonest and so called true variety as being that caused by traction of tumors or adherent organs while false diverticula were thought to be most

probably the result of excessive pressure from within the lumen of the bowel combined with a congenital weakness of the wall. These authors also called attention both to the frequency of occurrence of diverticula in the large bowel and to their tendency to extend into the epiploical appendage. As etiologic factors constipation with the impaction of hardened feces in the diverticulum was thought to be the important factor in the development of diverticulitis, the irritation from the continued presence of these hardened feces resulting at times in ulceration. This theory in their opinion accounted for the fact that diverticulitis occurred most often in the sigmoid area of the colon. Mayo and others also observed that most persons with this disease were over 50 years of age and tended to be obese. They also noted that chronic passive congestion had been mentioned as a factor both in the production of diverticula and as a cause of diverticulitis. These authors also distinguished between diverticulitis and peridiverticulitis. In the former they described acute inflammation of the mucosa within the diverticula without reduction in size of the lumen and resultant obstruction but with a tendency to acute perforation into the peritoneal cavity. In peridiverticulitis they maintained that the submucosa was chronically inflamed around the diverticula and the bowel lumen reduced, but perforation was rare because of the predominant reparative process. In 1907, when this paper was written, 5 cases of chronic obstructive diverticulitis with resection of sigmoid were described.

1908

Ashhurst[3] described a case which he assumed to be diverticulitis in a boy of 7 years 9 months. The boy had fever and a firm tender mass in the left lower quadrant. Exploration showed a tumor the size of a goose egg with several associated large lymph nodes in the mesosigmoid. There was no obstruction and no resection was done. The patient recovered completely with gradual disappearance of the mass within a period of three and one half months.

Telling[105, 106, 1] discussed the frequency of acquired diverticula in the large bowel, especially the lower descending colon and sigmoid, stating that they occurred chiefly in two rows, either at the

sides of the gut or close to the mesenteric attachment but rarely on the convexity and most commonly into the appendices epiploicae He stated that in the descending colon they were practically always filled with feces and noted that the aperture into the lumen was usually smaller than the maximum diameter of the diverticulum He cited three possible explanations for the origin of diverticula (1) that they are congenital and enlarge progressively during life (2) that they arise from pathologic causes and (3) that there is a congenital predisposition but that their formation depends on pathologic causes which operate during life His own theory with the balance of evidence at that time was that there is a pathologic origin and that no congenital arrangement of muscle fibers producing a predisposition had been demonstrated He considered the pathologic factors to include the narrow neck of the diverticulum collections of fecal material within the diverticula constipation increased intraluminal pressure and obesity Telling also expressed the opinion that diverticula exist much more frequently than had been previously believed

1910

Barbat[6] cited a long list of 126 reports on the subject of diverticulitis the majority from foreign literature summarized the theories of diverticula formation and etiologic factors in diverticulitis discussed the complications and the frequency with which this disease is confused with carcinoma and emphasized the high incidence of the disease and its complications

Hartwell and Cecil[54] in a pathologic and clinical study noted that a diverticulum of the intestine had been recognized as a pathologic entity for over 100 years They applied this term to any outgrowth of the intestinal wall not neoplastic in character which at some time had had a lumen connecting it with the intestine and whose walls are similar in structure to those of the intestines With this definition both Meckel s diverticulum as a congenital diverticulum and the vermiform appendix a a vestigial diverticulum can be included in this category of diverticula but they considered it useless to distinguish between congenital and acquired diverticula since no

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more to congenital weakness of the circumferential muscularis than to any other factor and constipation seems the important element in their development He also believed that low grade proliferative changes take place in the tips of the diverticula forming segregated epithelium similar in all re pects to the cell changes which occur in the masses of epithelium egregated about the ba e of a gastric ulcer From such epithelial proliferation which fills the entire diver ticulum he conjectured that infiltration of its wall developed form ing an histologic picture which must be diagnosed as carcinoma

1912

The first case of cecal diverticulitis was described by Potier[88] McGrath[77] wrote on the etiology and pathogenesi of intestinal diverticula He described the formation of the diverticulum as a herniation of the mucosa through the mu culari in the region of the ve sels u ually rupturing into the ve sels He observed that the e herniated structures usually involve the muco al and submu cosal coats He noted as conditions important in considering the development of diverticula obesity cachexia loss of intra abdom inal fat in previously obese individuals areas of weakness in an otherwise normal inte tine intraintestinal pre ure proximity of diverticula to points of entrance of blood ve els into the intestinal wall location of epiploic appendage infection involving lymph chann ls long blood vessel v all muscular deficiency congenital weaknes of muscularis constipation and old age He like Mayo[71] distinguished between diverticulitis and peridiverticulitis and he thought that cancer was associated with diverticulitis having ob served it in 25 per cent of hi series

1914

Bunts[16] called attention to a ca e of formation of a truly fal e diverticulum or herniation of the cecum at the ite of prior appen diceal surgery where the protrusion appeared to have taken place through a ring formed by the pur e string suture In this case the patient had recurrent attacks of right lower quadrant pain which disappeared after surgical correction

proof of either could be obtained except in the case of Meckel's diverticulum and the vermiform appendix These authors referred to the false diverticulum as not having all the structures found in the normal wall while the true diverticulum contains all these structures but they believed that the true might become the false by the loss of some of these structures They noted that diverticula had been found in every portion of the alimentary tract from the pylorus to the anal ring there having been reported diverticula even in the appendix itself They recorded however that the sigmoid was the favorite site and that in the rectum proper it was rare They observed that small intestinal diverticula occurred between the mesenteric leaves or close to them but that in the colon they were often placed laterally In their opinion the primary cause could not be determined but the existence of a congenital defect in the musculature was probable and contributing causes were most likely old age constipation and obesity They referred however to Ashhurst's report of the occurrence of diverticula in children and to other reports in individuals under 30 years They stated that while the diverticulum itself is harmless changes may occur which are similar to those occurring in the vermiform appendix They described these changes as Mayo had previously done inflammation with or without perforation abscess generalized peritonitis septicemia fistula formation into another hollow viscus especially the urinary bladder They mentioned also the possibility of chronic subacute inflammation with recurrent attacks of acute diverticulitis and they also described changes in the entire intestinal wall and its mesentery with or without obstruction resulting from the narrowing of the lumen or secondary to adhesions For the first time in their paper they mentioned the possibility of a superimposed carcinoma Included in their paper were 13 case reports of which 2 from autopsy material were in children age 6 and 10 years

1911

Wilson[118] formulated a theory of the development of carcinoma *from diverticulosis* In his opinion diverticula while they frequently follow the course of blood vessels probably owe their origin

plete obstruction in diverticulitis) (4) the group in which carcinoma develops in a diverticulum leading to the conclusion that when a tumor appears as diverticulitis and without acute symptoms in the colon and a chronic mass persists with less severe symptoms carcinoma should be suspected and resection performed

1924

Judd and Pollock[63] wrote on diverticulitis of the colon presenting various observations of interest They considered that it may be a static condition remaining unchanged for years and often not causing symptoms or it may progress to abscess formation fistulas or free perforation They had not observed it in any other part of the colon except the sigmoid They also mentioned the difficulty of distinguishing diverticulitis from carcinoma of sigmoid and stated that in their group of 137 cases there appeared to be no relationship between the two thus being the first to suggest that the theory of Wilson and others that carcinoma arose from diverticulitis was probably incorrect and that their occasional coexistence was coincidental It was their opinion that many patients with diverticulitis can be successfully treated medically surgery being indicated for perforation abscess formation and inability to diagnose the nature of a tumor formation They also suggested preliminary colostomy for obstruction and for the purpose of reducing inflammation by frequent irrigations of the lower colon and later lessened surgical risk These authors regarded proctoscopy as of little value unless the lesion was actually visualized

1929

Greensfelder and Hiller[5] wrote about cecal diverticulosis which in their opinion should be suspected if symptoms resembling appendicitis occurred in a patient who had had previous appendectomy Cecal diverticula may be either primary with etiology similar to that of sigmoid diverticulosis and occurring frequently in younger individuals or it may be secondary to traumata resulting from an operative procedure in the right lower quadrant These authors reported that in 5 395 major operations and 400 adult necropsies

1915

Case [1] was one of the first to draw attention to the x ray demonstration of diverticula and their complications and in the same year Carman [19, 20] joined the x ray pioneers with two papers on cases of diverticulitis and their x ray findings pointing out that left sided appendicitis could be excluded by the finding of a normal position of the cecum He also discussed the difficulties of differential diagnosis of diverticulitis from carcinoma, indicating that the presence of barium filled diverticula would tend to indicate diverticulitis He also suggested the taking of films in different views in order to pick up the extraluminal shadows of diverticula

1917

Mayo[75] wrote on diverticulitis of the large intestine reporting 42 cases which had had surgical treatment since the disease had first been recognized Of these 37 involved the sigmoid 1 the transverse colon 1 the ascending colon 1 the hepatic flexure and cecum and 2 the rectum The patients ranged in age from 27 to 73 and there were twice as many females as males He mentioned its clinical *similarity to appendiceal inflammation except that the symptoms* were usually on the left and in 34 cases a tender mass in the left lower quadrant was present In 13 cases (31 per cent) carcinoma coexisted with diverticulitis and the author considered this was more than a coincidence and that chronic irritation and inflammation of the diverticula led eventually to cancerous change He classified diverticulitis into four groups (1) self limiting diverticulitis and peridiverticulitis usually occurring in the middle aged and obese and usually recurrent (This group was in his opinion a poor risk for surgery which should only be considered if symptoms were serious or chronic relapsing) (2) the group with abscesses and *fistulas where conservative surgery should be employed* (3) the group with obstruction where it is difficult to distinguish diverticulitis from carcinoma (The author here offers two differentiating points (a) a long history of symptoms in diverticulitis (b) complete obstruction frequent in carcinoma as contrasted with incom

Small doses of mineral oil and an anti-constipation diet are prescribed, the dietary regimen being highly essential. With complications they thought surgery should be done, but it was accompanied by a high mortality rate. The authors recommended as an operation of choice a graded procedure consisting of drainage and subsequent resection and anastomosis. Often prolonged drainage alone produced recession of tumefactions and disappearance of clinical symptoms, rendering further intervention unnecessary. The pathologic changes in diverticulitis occurred probably because of stasis of the fecal stream in this portion of the colon with formed stool preventing emptying of the diverticulum when it was packed with feces. They thought that local inflammatory changes then began in the mucous membrane of the diverticulum, which became atrophied. There was round cell infiltration of the submucous coat and later ulceration. With progressive change of this type in the bowel wall and the mesentery itself, symptoms of inflammation and obstruction occurred with perisigmoiditis and mesenteritis. The changes in the coats of the diverticulum varied from attenuation of the musculature to its complete absence when the wall was made up only of mucosa and serosa. The mesentery and its attachment became thickened and contracted with considerable tumefaction. While free perforation was rare, localized perforation with abscess and fistula was not uncommon.

1933

Wilkinson[117] wrote a paper on diverticulitis in which he referred to the fact that Friend noted diverticula of the large bowel as early as 1730, more than a century before Cruveilhier's pathologic description of them. Wilkinson also referred to Klebs'[6] papers in 1869, which first directed attention to the relation of diverticula to the point in the bowel wall at which blood vessels traverse it. Wilkinson also credited Graser with arousing interest in 1899 in the entity of diverticulosis following a long period after Cruveilhier's description in which nothing had been written about it. Wilkinson discounted the value of differentiation of true and false diverticula. He mentioned the lack of symptoms until inflammation occurred man

performed at the Michael Reese Hospital there were 4 cases of traumatic solitary cecal diverticula 2 at operation and 2 at autopsy They considered their etiology to be either eversion of cecum between two constricting adhesive bands or traction of a narrow adhesion or eversion at the stump site as a result of weakness due to migration of a silk purse string suture into the cecum or following the rupture of a stump abscess into the bowel lumen

1930

Rankin and Brown[83] writing about diverticulitis stated that diverticulosis occurred probably in about 1 per cent of all persons and in about 5 per cent of patients with symptoms referable to the large bowel Of those individuals with diverticulosis they estimated that about 17 per cent had diverticulitis in most cases chronic with exacerbations Concerning etiology the authors tend to agree with Beer that the chief factor is inherent weakness of the muscle wall abetted by obesity and constipation and that diverticulitis is probably the result of improper emptying of bottle shaped sacculations with subsequent inflammatory reaction necrosis and occasional perforation In 227 cases reviewed in their paper a malignant condition was associated with diverticulitis in only 4 cases and in 679 cases of carcinoma of the colon only 4 cases of diverticulosis were found These authors believed that diverticulitis occurred almost entirely in persons of middle age and inclined to be corpulent and leading sedentary lives They believed it usually ran a chronic course with exacerbations and yielded satisfactorily to medical treatment They noted that the outstanding symptom was pain in the left lower abdomen frequently associated with constipation They thought that while bleeding was not usually associated with diverticulitis it might occur giving rise to a suspicion of a malignant lesion which was frequently not found Bleeding usually arose in the opinion of these authors from the anal canal They considered tumefaction the result of inflammatory reactions commonly associated with diverticulitis Medical treatment recommended by these authors consisted of bed rest irrigations of the affected segment with warm saline solution and watchful waiting

around the wall of the bowel The pouches are separated by ridgelike elevations

(5) Diverticula can actually be seen more often than is usually believed especially in the absence of inflammation Buie cautions that the polyp in an unusual location should be recognized

1943

Five years later than when Buie first wrote about the proctoscopic findings another paper was written by Jackman and Buie[60] on proctoscopic aid in the diagnosis and differential diagnosis of diverticula The records of 242 patients who had had both procto copic and x ray studies of the colon were studied Of these 160 cases (66 per cent) showed evidence of diverticulitis by proctoscopic examination in 35 cases diverticula were visualized and in an additional 72 cases sigmoidal sacculations as described in Buie s paper of 1939 were described In the other 53 cases such findings as immobility sharp angulation reduced lumen al o previously described by Buie strongly sugge ted the presence of diverticula of the sigmoid and in all these cases the proctologic findings were confirmed by x ray The authors also reported 74 per cent successful diagnostic re ults in 50 ca es in which colostomy had to be performed as an emergency mea ure for ob truction in the lower bowel The proctoscopy was performed either through the colonic stoma or the anus

1944

Young and Young[11] in a paper on diverticulitis of the colon emphasized the relative frequency of the disease the errors in diagnosis and the too high morbidity and mortality They compiled statistics showing an incidence of 5 2 per cent diverticulosis in 70 572 colons examined by barium examination in the living and by autopsy They estimated that 12 to 15 per cent of the e developed diverticulitis but in three reported series totaling 3 915 cases with diverticulosis of the colon the incidence of diverticulitis was 34 3 per cent The e statistics showed 22 per cent to have been

fested by abdominal pain usually in the left lower quadrant or peri umbilical fever constipation with intermittent diarrhea and a palpable mass in the left lower quadrant For the first time hemor rhage was described as a complication He emphasized the impor tance of x ray diagnosis for diverticulosis and of clinical and x ray findings for diverticuliti in which condition x ray showed diver ticula in proximity to a constant irregularity and narrowing of the *lumen of the gut He also mentioned the fact that clinically, roent* genologically and even at surgical exploration the differentiation between diverticulitis and a malignant lesion might be very difficult In the treatment of both diverticulosis to prevent diverticulitis and of diverticulitis itself he advi ed against the use of laxatives and enemas since these were likely to force more material and bacteria into the diverticula He recommended the attempt to keep stools normally formed and to prevent overactive peristalsis and increased intraluminal pressure He suggested for the treatment of diverticu litis bed rest the avoidance of purgatives laxatives and even mineral oil the use of tincture of belladonna and of an easily digestible diet with warm fluids He considered surgery necessary only for complications

1939

Buie[14] *introduced the possibility of diagnosis of sigmoidal* diver ticulosis and diverticulitis by five proctoscopic signs

(1) There is limited mobility of a segment of bowel which is normally freely movable This immobility is not confined to the rectum as is the ca e when there is pelvic di ease or a fixed retro verted uterus

(2) There is a sharp turn of the bowel where it is immobilized by diverticulitis with difficulty in or impo sibility of passing the procto cope beyond the angulation

(3) There is a mucosa showing adherent folds and a contracture of the lumen The muco a may also be edematou

(4) Where there is no inflammation and the igmoid is mobile shallow sacculations may be seen extending partially or wholly

1940 and 1942 believed that diverticula developed essentially as a result of a combination of physical forces with weakening or spreading of the circular muscular layer at the points of entrance of its blood vessels due to intracolonic pressure from constipation muscular spasm or other causes Another view held by Fansler[43] was that in middle age degenerative changes occurred in the muscle layer followed by traumatization from hard stools and gas distention but that this damage did not necessarily occur at the points of vascular penetration Schlotthauer also referred to Wierda s[11] belief that diet was a factor since in 3 rats fed on a high fat diet he found diverticulosis of the colon Schlotthauer also cited a fourth theory that for the formation of a diverticulum there had to be a congenital anatomic deficiency in the wall of the colon which acted as the starting point since diverticulosis occurred sometimes in young people before the age at which degenerative changes take place For support of this theory he quotes Poate[87] Lynch[69] Erdmann[3, 40, 41] Badia[5] Beare[8, 9] and Cave[4, 5] Such cases as Schlotthauer presents in this paper could be explained on this basis He reported colon diverticulosis present in 7 brothers of one white family consisting of 7 males and 2 females the ages ranging from 49 to 70 years and their habits of living social status occupations place of abode size and weight varying greatly In this instance it would be difficult to ignore heredity as a factor in etiology

Morton[80] writing on diverticulitis of the colon called attention to the fact that this disease is of interest to internists surgeons pathologists gynecologists and urologists He restated Case s definition of diverticulosis as the finding of diverticula in a routine radiographic picture of the large bowel representing no significant pathology and no symptomatology and occurring in 5 per cent of post mortem examinations of individuals of 40 years and over at the Mayo Clinic Morton s study was comprised of 111 cases of diverticulitis with spasm and 85 cases with multiple complications In the group of 111 cases with spasm the patient was typically middle aged or older obese habitually constipated and sedentary Clinically there was often lower abdominal pain with sudden onset and with constipation often preceded by several loose stools Distention

operated upon In one series 15 *per cent presented complications* requiring surgery These authors thought the incidence was slightly greater in men than in women and that only about 0 3 per cent occurred below the age of 30 They also reported 5 to 17 per cent of bleeding in diverticulitis with rare massive bleeding They recommended prophylactic treatment when diverticulosis was diagnosed *such treatment consisting of low* roughage diet *mineral oil* to promote regular elimination the avoidance of all irritable cathartics and enemas and the use of tincture of belladonna In all respects except in the use of mineral oil these measures coincided with those recommended by Wilkinson 11 years previously In like manner the suggestions offered for the treatment of diverticulitis agreed with those of Wilkinson The authors recommended surgery for acute perforation obstruction fistula formation localized abscess and suspicion of cancer In an analysis of 84 cases at the Faulkner Hospital in Jamaica Plain Massachusetts 86 per cent were over 40 years old the youngest being 37 The sexes were about equally divided Blood was found in the stools in 26 per cent of cases in which no other cause for blood was found and the incidence of blood was greater in chronic diverticulitis (33 per cent) than in acute diverticulitis (20 per cent) The most common complaints in acute diverticulitis were of abdominal pain (usually in the left lower quadrant) and elevation of temperature and leukocytosis In the chronic form of diverticulitis 79 per cent of the cases in this study had abdominal pain with symptoms of indigestion especially gas distress and nausea These authors found positive sigmoidoscopic findings spasm immobility sharp angulation and mucosal edema in 71 per cent of their cases but no actual diverticular sacs were visualized

1946

Schlotthauer[96] presented a report of 7 cases of diverticulosis in one family of 9 persons He discussed the current thought on etiology defining it as a herniation of the mucosa and submucosa of the intestine through a defect in it circular muscular layer He *referred to* Ceballo [26] Dixon [3] and Edwards[38] who in the years

colon which had been involved by diverticulitis Morton also suggests a conservative treatment consisting of bed rest simple diet antispasmodics heat to the abdomen and sedation He believed antibiotics were unnecessary Surgery in his opinion should be reserved for complications

1949

Carlson and Hoelzel[18] reported investigations on rats which revealed that diverticula were found in areas contiguous to lobulated fat deposits and that abnormally high intracolonic pressure was a causative agent in the development of diverticula in the colon It was thought by these workers that the bowel wall was weakened as a result of fat infiltration and that herniation of this weakened part of the wall occurred into a fat infiltrated peritoneal sacculation When a concentrated low residue diet was fed the rats there was a continuous contraction and increased intracolonic pressure whereas this did not occur when the diet was bulky

1951

Ewell[4] wrote on a complication of diverticulitis the intestinovesical fistula He stated that about 50 per cent of all intestinovesical fistulas were due to diverticulitis of the colon and consequently all individuals with diverticulitis of the colon were potential candidates for this complication which like any fistula secondary to inflammatory disease almost always developed after a localized abscess formation and was usually a tortuous tract For the diagnosis of this condition the history of pneumaturia or the passage of feces through the urethra were usually considered pathognomonic of intestinovesical fistulas The author stated that this was true of passage of feces but pneumaturia might be due to other causes as well Passage of urine through the rectum although uncommon was another cardinal symptom of intestinovesical fistula The physical examination should be supplemented by cystoscopy excretory urography cystograms gastrointestinal x ray and proctosigmoidoscopy With cystoscopy the opening might be visualized or bubbles of gas or fecal matter be seen extruding into the bladder A barium enema revealed the fistula

nausea vomiting fever occasionally chills tenesmus and bladder symptoms might follow the onset of pain Tenderness and a palpable mass in the left lower quadrant together with elevated temperature pulse rate and white cells were the chief diagnostic signs Only 2 of these 111 cases were under 30 years of age and both sexes were about equally represented In addition to the usual pain in the lower abdomen constipation diarrhea distention and vomiting blood was found in 32 cases (bright red in 24 cases and tarry stools in 8 cases) If 10 of these cases in which other possible causes for blood were found were eliminated from this group there was still an incidence of 20 per cent reasonably ascribable to diverticulitis When no complications were present the author believed that the disease was self limited and improved or subsided in three to seven days under medical care during which time the surgeon must exercise restraint

In the 85 cases with complications perforation occurred in 39 cases fistula in 22 cases obstruction in 34 cases cancer in 17 cases some having multiple complications In the group of 39 cases with perforation 3 had perforated into the peritoneal cavity with resulting peritonitis In the other 36 there were localized abscesses and the symptoms previously described for diverticulitis were increased in intensity Of this group 10 died in the hospital In the 22 cases with fistula the abscess of perforation had opened or made its way into a neighboring organ to the skin in 11 cases into the bladder in 8 cases the urethra in 2 cases the small intestine in 2 cases the cecum in 1 case the rectum in 2 cases the vagina in 4 cases retroperitoneal tissues in 1 case to form an ischiorectal sinus in 1 case and a sinus into the mesocolon in 1 case In 11 of these cases the fistulas were multiple In the 34 cases of diverticulitis with obstruction due to infiltration of the intestinal wall there had been repeated infections and scarring and thickening of the colon causing gradual occlusion of the lumen There were also other possibilities to be considered for the cause of obstruction chiefly adhesions around an abscess cavity and adherence of the small intestine to an acutely infected diverticulum In the 17 cases where cancer was associated with diverticulosis only four of the cancers were in the area of the

the lesion was a cancer even with a completely annular tumor These authors recommended the occasional use of a double contrast enema for identification of the lesion They also recommended as helpful features in the differential diagnosis of diverticulitis and carcinoma (1) greater length of area of involvement in sigmoid diverticulitis than in carcinoma (2) much better preservation of the mucosal contours in diverticulitis (3) more complete obstruction (increased by spasm) in diverticulitis (4) if a mass was present usually tenderness in diverticulitis (5) abrupt transition from relatively normal to abnormal bowel in carcinoma with cuffing overhanging edges or shelving often visualized

Swinton[104] wrote on the surgical aspects of diverticulitis stating that the policy of the Lahey Clinic had been to operate on patients with diverticulitis only if complications had developed conservative treatment being adequate for the majority of uncomplicated cases of diverticulitis This author also mentioned the possible occurrence of an acute exacerbation from the use of castor oil or other laxative in preparation for roentgenographic or sigmoidoscopic examinations His indications for surgical intervention were (1) evidence of acute perforation (2) abscess formation (3) obstruction (4) inability to exclude diagnosis of a malignant tumor (5) fistulas (6) repeated hemorrhages (7) failure to obtain relief by conservative measures His choice of surgical procedures was (1) for acute perforation simple closure of the perforation with a proximal diversional colostomy when indicated as in an extensive process or when obstruction is suspected (2) for abscess formation incision and drainage followed by resection of the diseased process after the acute process subsided (3) for obstruction a three stage procedure a right transverse Mikulicz type of colostomy resection of the tumor and later closure of colostomy If malignant disease could not be excluded in the presence of an obstructing tumor he recommended segmental resection of the involved area and if possible examination of the removed tissue before a final decision was made as to the operative procedure to be used For enterovesical or other fistula he considered a three stage procedure indicated a preliminary right transverse colostomy followed in four to six months

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Wigh and Swenson[116] wrote on the roentgenologic aspects of diverticulitis and its complications They stated that the generally accepted incidence of diverticulosis was 5 to 10 per cent and of these 12 to 22 per cent developed diverticulitis at some time Peri diverticular abscesses were identified in two ways (1) by a palpable mass contiguous with or displacing the bowel fluoroscopically (2) by their recognition as abscesses on the roentgenograms because their opening into the lumen of a diverticulum was sufficiently large to permit the ingress of opaque mixture These authors stated that fistulas were a fairly common complication of diverticulitis (10 to 15 per cent of all cases of diverticulitis that had surgery also had bladder fistulas according to Bockus) Fifty per cent of vesicocolic fistulas from inflammatory lesions resulted from diverticulitis and these constituted twice the number of those due to carcinoma When no diverticula were visualized carcinoma had to be considered as the origin of the fistulous tract

While localized inflammatory processes usually subsided and a *normal* bowel was restored repeated attacks of inflammation caused a thickening of the bowel wall and reduction in the size of the lumen with possible obstruction The authors estimate that two thirds of the cases of diverticulitis had their complaints based on *obstruction* They also made the observation that with the barium enema spasm was produced giving an appearance of greater obstruction than was demonstrated when the barium passed distally This was often only transitory spasm and was not usually seen when

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Smith[97] discussed the theories of etiology with regard to constipation and he considered it a factor but while constipation is more common in females than in males diverticulosis occurred more frequently in males He mentioned the theory of Devine and Devine[34] who stated that straining at stool was a contributory factor yet while the expulsive effect was more marked in the rectum than in the sigmoid diverticula appeared more often in the sigmoid and fecal material was firmer in the rectum than in the sigmoid The theory that increased intraluminal pressure caused the pulsion type of diverticula could be contested in his opinion by the fact that although these positive pressure relationships were present from birth diverticula occurred chiefly in later life He referred to Yeomans[1 0] four possible reasons for the development of diverticula (1) hernial protrusion following emerging veins (2) increased intraluminal pressure causing herniation *through weak points as a result of irregular contraction* (theory of Keith) (3) In final analysis it was a matter of weakness existing for some cause in the intestinal coats because of which a pouching of the coats occurred when undue pressure arose as suggested by Hartwell and Cecil (4) It was Erdmann s opinion that *all were of congenital origin and no single factor could explain all diverticula* Smith also discussed the place of sigmoidoscopy in diagnosis as having increasing value with experience and reviewed Buie and Jackman s findings Smith also noted that the presence of diverticula is sometimes disclosed during sigmoidoscopy by displacement of their fecal content as a result of slight pressure from the distal tip of the sigmoidoscope He had observed the diameters of the orifices to vary from several millimeters to 2 centimeters Rarely an inverted diverticulum would resemble a polyp by sigmoidoscopic examination When diverticulitis was present sigmoidoscopic diagnosis became more difficult and there was no typical picture it often being impossible to rule out carcinoma A long history suggesting gradually increasing ob

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Albright and Leonard[1] wrote on the management of diverticulitis coli In general they believed that preventable bowel invalidi m serious surgical complications and fatalities from diverticulitis might sometimes be avoided by good management including the establishment of a simple effective bowel management regimen maintenance of an adequate anal outlet and proper election and timing of surgical intervention In the authors opinion more em phasis should be placed on the role of spa tic con tipation and anal back pressure in perpetuating symptomatic diverticulitis and initiat ing complications Bed rest bland low residue diet avoidance of cold fluids antispa modics sedation heat to abdomen and hot water to drink with the avoidance of cathartics were recommended Anal spasm or fibro is may require anal dilatation under ane thesia external sphincterotomy or the operative correction of associated anal disorder The authors also emphasized the fact that with recent surgical advance re ection in symptomatic cases can be done in selected patients They used a proximal diverting colostomy before re ection and stated that colo tomy clo ure without re ection failed in over two thirds of cases in which it w is done While pre resection bowel preparation for a week is adequate in carcinoma a first stage fecal diversion for everal month is be t in inflammatory diverticu litis They al o believed that re ection by exteriorization was u ually afer than primary re ection unless the egment involved was hort the inflammation chronic or slight and di tal obstruction was absent

1952

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1952

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sive attitude should be taken i e primary resection rather than the *defunctioning of the bowel for a period of several months before* resection is done a form of treatment often advised for diverticulitis These authors found only 62 definite cases of coexisting carcinoma and diverticulitis of the colon in the literature up to May 1950 They also reviewed the historical data on diverticulosis and diverticulitis mentioning the description in Baillie s Anatomy in 1794 They called attention to Virchow s[111] description of isolated circumscribed adhesive peritonitis of the colon Virchow failed however to associate this lesion with diverticula which he had described The authors stated that Graser[49] in 1898 was the first to consider the inflammatory stenosis of the sigmoid and rectum as simulating carcinoma of the colon while Beer in 1904 raised the question of predisposition of the inflamed bowel to the development of carcinoma Following Wilson s paper various authors already reviewed in this book perpetuated the theory that diverticulitis predisposed to carcinomatous development However Rowe and Kollmar believed that since 1924 sufficient statistical evidence had shown that the occurrence of carcinoma and diverticulitis was merely coincidence Their survey of several hospitals showed that among 700 patients with carcinoma of the colon only 7 had coexisting diverticulitis and carcinoma and these authors made the point that only 3 (0 43 per cent) had carcinoma and diverticulitis in the same segment The authors stated that a strong suspicion of cancer is justified only if weight loss and bleeding with obstruction and anemia are present while a palpable mass and fistula formation are more suggestive of diverticulitis They stated that bleeding occurs with both diverticulitis and diverticulosis in variously reported incidence (5 to 26 per cent) but that an exhaustive search for other origin should always be made In addition to proctoscopy as a helpful diagnostic aid occasionally cytologic studies with the Papanicolaou technic are helpful but precise x ray examination is still the most accurate method of diagnosis These authors also recommend the more frequent use of primary resections and anastomoses to care for possible carcinoma and to decrease surgical morbidity

1953

Case and Shea wrote on acute diverticulitis of the cecum They tated that all inflammatory di ea es of the cecum are rarely diag nosed correctly even at operation where diverticula may be buried in a mass of inflamed edematous tissue and thought to be neopla tic and therefore requiring unnece sarily radical surgery They re viewed 7 cases (1 7 per cent) of cecal diverticula at St Vincent s Hospital They discus ed the etiology dividing them into true and false type considering that some are congenital and represent per si tence of an early embryologic appendix They quoted Greens felder and Heller concerning the other mechanical etiologic factors but they stated that mo t solitary cecal diverticula are congenital true diverticula with all the muscle layers represented in their walls Since signs and symptoms are usually identical with those of acute appendicitis acute diverticulitis can usually be diagnosed only at operation In the chronic form radiography is useful but here too it may be difficult to di tingui h from carcinoma tuberculosis of the cecum actinomycosis of the bowel or nonspecific ulcers of the cecum many of which the authors believed may be the end result of necrotic processes in a diverticulum of the cecum Regional ileitis with extension to the cecum and amebic ulcer of the cecum must also be differentiated The authors reported 4 ca es of cecal diverticu litis in 2 of which the complications of perforation ab ces forma tion and fistula formation were pre ent

Starkloff and Bindbeutal[100] discussed the differential diagno is of diverticulitis and carcinoma of the colon and pre ented a tudy of 259 ca es of carcinoma of the colon and 30 ca es of diverticulitis Of the e 25 patients had coexisting carcinoma and diverticulo is of the same egment the rectosigmoid and 6 had coexi ting car cinoma and diverticulitis 4 of whom had the coexi ting lesions in the same egment (1 5 per cent) This figure agrees with other pre vious statistics and emphasizes that the relation hip is coincidental In 5 ca es however the clinical diagnosis of diverticuliti proved to be incorrect the lesion being carcinoma without diverticula In their conclusions they empha ized the fact that no reliance can be

placed on symptoms and signs except for bleeding and cachexia which should arouse suspicion of carcinoma *In their series bleeding was present in 62 per cent of carcinoma and 19 per cent of diverticulitis* X ray examination with reliance on a normal appearance above and below the malignant growth is subject to pitfalls The authors advised a more radical surgical approach especially if carcinoma is strongly suspected

Lewis and Hurwitz[68] wrote on surgical treatment of sigmoid diverticulitis reporting 10 consecutive cases of severe and complicated diverticulitis of the sigmoid with resection of the diseased segment and end to end anastomosis without mortality Six patients did not require previous or complementary diverting colostomy while 4 had an earlier diverting colostomy all of which were closed later These authors laid down principles for the treatment of three complications For acute perforation they recommended incision and drainage closure of perforation and a proximal diverting colostomy with later closure for obstruction a proximal diverting colostomy was also necessary with resection of the diseased segment and redundant sigmoid in three to six weeks following the preliminary procedure (These authors believed that intraperitoneal closure of the colostomy should be done after the integrity of the suture line *has been demonstrated which usually is the case in approximately three weeks*) for fistulas they use a diverting colostomy early resection of the colon with excision of fistulas and later closure of colostomy In their opinion a more aggressive surgical approach is *necessary because of the morbidity and mortality associated with* this disease diverticulitis

Vaughn and Narsete[109, 110] wrote on the rare form of diverticuliti that of the ascending colon They stated that up to 1953 only 14 cases *of diverticulitis of the ascending colon had been reported to* which they added 2 of their own Of the previously reported cases most had been in patients between 10 and 40 years old whereas of their 2 cases 1 occurred in a 50 year old man and the other in a 67 year old woman *and in both cases the atypical finding of melena* was present One patient had diarrhea and melena for four days occurring two months and again one week before admission There

was bright blood by rectum but the patient al o had hemorrhoids The other patient had left subco tal pain intermittently for two years and melena for two weeks The diagnosis of these le ions is made by the u e of barium enema examination with serial ex posure Treatment of the disease is usually surgical because acute appendicitis cannot be ruled out In 14 cases previously reported their location varied 6 being medial 6 lateral and 2 anterior The syndrome of this condition simulates appendicitis but when diver ticula are located in the ascending colon the appendix is less likely to be involved than when they are in the cecum The incidence of all diverticula of the large bowel i according to these authors 3 to 7 per cent and of these only 1 5 to 2 per cent occur in the right half of the colon These authors estimate that in about 15 per cent the bowel becomes inflamed The cau ative factors of diverticula in the right colon have not been accurately determined but the following should be considered

1 E te o ou yst c mmonest in ileoc cal areas
2 Hered tary f tor not pos ble of p oof
3 Eve si n of a weakened bowel wall
4 T a t on on th pp nd ces ep ploic me e tery om ntum by int a ab dom nal dhe ns
5 Weaken of the bowel wall by a cular entry
6 I rea ed i traluminal pres u e
7 Cathart cs and purgatives
8 Muco l ulcerations

In previously reported cases the ratio of females to males was 2 to 1 whereas in diverticula of the cecum itself it was about equal Diverticula of the ascending colon had a greater tendency to occur in the younger age group when compared with cecal diverticula

Another paper on right colon diverticulitis was written by Unger[108] who reported 6 ca es He tated that 132 ca es had already been reported in the literature Clinically it is indistingui hable from acute appendicitis In Unger s cases the age range was from 26 to 64 years and ex distribution equal In all ca e acute diver ticuliti was su pected Diverticulectomy complemented by appen dectomy if feasible is the operation of choice but when *cecal neo plasm* cannot be excluded ileocolic resection is justified Wherever

experience attended this operation and serious complications can thus be prevented

Hoar and Bernhard [7] wrote about the complication of bleeding in diverticular disease They stated that this complication had received little attention They *considered as still not conclusively* proved the theory of pathogenesis which assumes that the outpouching of the mucosa occurs through the muscle layers at the point of emergence of a nutrient artery to an appendix epiploica They reported on the incidence of rectal bleeding in 347 cases from a 10 year period at the Peter Bent Brigham Hospital in which the bleeding originated from diverticulosis or diverticulitis An additional 38 cases of diverticula and concomitant carcinoma were also reviewed There were 111 patients with diverticulitis 42 (37 per cent) had rectal bleeding 31 of whom had no gross evidence of rectal bleeding or melena but had two or more positive stools *for occult blood Nine patients had a history and gross evidence* of bleeding or the stool was strongly positive to the guaiac test Two patients had uncontrolled rectal hemorrhage and required surgical treatment as a life saving procedure Of these 12 cases 11 had associated obstruction and 1 had abscess formation The other 30 had no major complication These data showed that bleeding *per se* associated with diverticulitis has no significant relationship to other complications except obstruction Of the total group of 385 cases a carcinoma was present in an area of diverticulitis in only 14 (3 6 per cent) As a correlating study the authors reported that of 466 cases of carcinoma of the colon and rectum over a 10 year period a concomitant x ray diagnosis of diverticulosis was made in 38 cases (8 per cent) which is approximately the expected figure in the middle or old age group of the entire population These authors reported 4 cases of massive hemorrhage with *diverticular disease 3 of these patients died which led the authors* to recommend early operation provided other sources of bleeding are eliminated ulcerative colitis is absent by proctoscopy and diverticula are present by x ray examination The authors stated that while cancer of the colon is the *commonest cause of rectal bleeding it is relatively uncommon as a cause of massive hemor*

rhage Of 236 case of diverticulo is (without carcinoma) detectable rectal bleeding was present in 39 or 16 per cent

Higgins and Burger [6] wrote on an uncommon form of diverticulosis and diverticulitis that of the vermiform appendix stating that it occurs in about 1 of every 200 appendices and may be congenital with all layers of the bowel intact or acquired with no muscularis layer Edel [37] in 1894 described the e appendiceal diverticula and since then there has been considerable discrepancy in the reported incidence and some controversy over the classification and pathogenesis These diverticula are often overlooked at surgery and the diagnosis is made only by the pathologist They are not an extension of diverticulosis of the colon The authors reported a case of retrocecal appendix with five diverticula projecting from the antimesenteric border one acutely inflamed and perforated

Colcock and Sass [9, 31] wrote on the occurrence and complications of diverticulitis in the aged They stated that the highest incidence of this disease occurs in the sixth or seventh decade of life and that it is more common in overweight patients with sedentary occupations who suffer from con tipation Therefore it hould be suspected in any patient over 40 years of age who is overweight and complains of repeated attacks of left lower quadrant distress They mentioned the possibility of occlu ion from inflammatory reaction in the bowel and called attention to the fact the dysuria should be considered a warning that the inflammatory proce s may be involving the bladder wall They regarded rectal bleeding as an unimportant symptom of diverticuliti and suggested the need for earching for other sources of bleeding if this is pre ent They mentioned the fact that the x ray finding of a rather long area of narrowing suggests diverticulitis rather than cancer in which the narrowed area is shorter They also mentioned the picket fence or saw tooth appearance of the mucosa which is u ually seen throughout the involved area in contrast to its absence in malignant lesions Also in diverticulitis the area is more tender and rigid when palpated during fluoro copy and the o called *lipping* i ab ent In a review of 50 case of carcinoma and 50 ca es of diverticuliti the complications of perforation and ab cess and fi tula occurred much more

often in diverticulitis (40 per cent and 34 per cent) than in carcinoma (6 per cent and 2 per cent) obstruction likewise was present more often in diverticulitis (22 per cent) than in carcinoma (16 per cent) They believed that most cases of diverticulitis can be adequately managed by conservative treatment but about 10 to 20 per cent of these patients will have repeated attacks or complications They recommended surgical treatment for recurrent or extensive diverticulitis to avoid complications which they believed are especially hazardous in old patients In such cases they thought the be t operation is a proximal transverse colostomy followed in everal months by re ection and anastomosis and finally by closure of the colostomy but if carcinoma is su pected resection must be done in two to three weeks with further procedures depending upon the pathologic findings

1955

Friesen and Schmidt [46] reviewed 301 cases in which the diagno is of diverticulosis or diverticulitis had been made Of these 7 per cent required surgery with stenosing obstruction as the chief indication The authors mentioned the fact that antibiotics have decrea ed the incidence of abscess and fistula formation The choice of surgical procedure depended on many factors such as the age and general condition of the patient the acuteness of the process the pre ence or absence and degree of obstruction the number and duration of previous attacks the extent of inflammatory reaction the pre ence of fistula or abscess and the mobility and accessibility of the involved segment

Gilchri t and Economou [47] wrote on urgical treatment of diverticulitis of the colon They stated that one third of persons over 45 have diverticula of the colon most commonly in the sigmoid next frequently in the de cending colon but at times scattered throughout the colon They al o stated that diverticula are not een below the peritoneal reflection and in their opinion they are pul ion diverticula Increa ed intraluminal pres ure a an influence on their formation is indicated by the fact that in ca e of carcinoma of the sigmoid with ob truction diverticula neare t the ob truction are

deeper and more inflamed than the more distant ones The e authors believed al o that inflammation a ociated with the diverticula may be the actual cau e of fixation in carcinoma of the sigmoid which makes the prognosis better in the e cases Abscesses are formed by the trapping of feces in the diverticulum Their indications for surgery are the usual ones (1) free perforation which may occur in a rather movable portion of the sigmoid (2) abscess formation (3) partial or complete obstruction (4) fi tula formation (5) inability to exclude carcinoma (6) recurrent disability and pain These authors also discuss the problem of bleeding in the presence of diverticulitis stating that it must be assumed that polyps or carcinoma are also pre ent and even if they are not definitely found the involved portion of the colon should be removed and the re t of the colon explored When surgery is performed and the descending colon as well as the sigmoid is involved both should be removed thus excising mo t of the disea ed bowel and promoting loose stool resulting in less danger from remaining diverticula

McMillan and Jamieson[78] wrote on trends in surgical treatment of diverticulitis of the colon They considered the five complica tions of diverticulitis to be (1) perforation (2) ob truction (3) fistula formation (4) carcinoma and (5) bleeding They con sidered the small slowly developing and walled off perforation as possibly subsiding but frequently recurring A right transver e colostomy with inci ion and drainage of abscess is indicated if medical management is unsuccessful They also thought that acute perforation into the peritoneal cavity is more common than usually believed and requires drainage and colo tomy For obstruction they believed that failure to use prompt surgical treatment leads to disastrous results when obstruction is cau ed by fibrotic edematou or granulomatous stenosis or di tortion of the colon in which ca es intubation enemas and antibiotics are unsucce sful They regarded treatment of external or internal fistulas without resection of the di eased colon as di couraging They al o stated that inability to distingui h carcinoma from diverticulitis i one of the mo t definite indications for re ection They al o found that bleeding *is often severe enough to warrant operation* They expres ed the opinion

that diverticulitis may be *disabling and hazardous if not consistently controlled by a good medical program*. They considered the disease more severe in patients under 50 years of age and that resection is indicated while the patient is in good general condition. Unexplained urinary symptoms and severe residual deformity of the *sigmoid are in their opinion indications for surgery*. The surgical measures discussed by them are (1) cecostomy which they consider frequently inadequate and unsatisfactory as a definitive or preliminary operation, (2) colostomy as a necessarily palliative or preliminary operation in patients in poor condition (but they regarded closure of the colostomy without resection as frequently resulting in further exacerbation or complication of the disease). The best operation is in their opinion resection with anastomosis which may be done in two or three stages depending upon the condition of the patient. This can usually be accomplished safely in three to four weeks and be followed in another three or four weeks by closure of the colostomy.

Judd and Mears[6] wrote on the surgical progress toward a wider application of a single stage resection of diverticulitis of the sigmoid. They believed that in the past surgery has been used only in cases with complications and that from experience a multiple stage operation *was considered necessary. They thought that this approach* should be re-evaluated and that a prophylactic resection of the colon during a quiescent interval of the disease has much to recommend it. Under these circumstances a single stage primary resection can be done with very low morbidity and very little risk because of modern improvements in anesthesia and advances in antibiotic therapy and preoperative and postoperative care. They recommended this elective surgery in patients with a history of recurrent attacks of diverticulitis even though the patient is in apparent good health and x rays show only scattered diverticula, the purpose of such surgery being to spare the patient the increased risk, discomfort, *inconvenience and expense of multiple stage procedures* when serious complications are present. They emphasized the indications of such elective surgery not only for patients with recurrent attacks *in spite of good medical care* but also for all patients with

urinary symptoms a ociated with an attack of diverticulitis (u ually male patients) and when carcinoma cannot be ruled out In their experience 6 of 68 patients had hemorrhage which could not be attributed to any other cause

1956

Bacon and Valiente[4] wrote on the surgical management of diverticulitis They emphasized the greater need for preventive re ection particularly because of the low mortality and morbidity now possible through control of colic bacterial flora improved nutritional control and electrolyte replacement Preventive resection can usually be done in one stage *with conservative preoperative* treatment in ca es of acute diverticulitis delaying the operation until the acute infection has subsided If a liberal segment of bowel is re ected by left hemicolectomy and ana tomo is of the distal transver e colon to the low igmoid or rectosigmoid rehabilitation of the patient is excellent in mo t cases Even when the policy of preventive resection i u ed there will till be pecial problems arising from the fact that diverticulitis is often first diagno ed when a complication occurs For acute sudden perforation of the colon the authors recommended repair of the site of rupture with or without transver e colostomy When the bowel wall is friable local repair cannot be done and exteriorization is the be t treatment but if the bowel cannot be readily mobilized the inflammatory area is drained and transverse colostomy is performed with Neomycin solution (5 Gm in 500 ml of sterile solution) directly injected into the bowel lumen and flushed through the colon by gentle manipulation Fistulas are treated by resection of the disea ed egment and removal of the fi tulous tract and the viscus penetrated by the fistula i repaired A three stage procedure is cho en if there is preoperative evidence of active infection and inflammation with three weeks to three months elapsing between colostomy and re ection Strictured areas if inflammatory reaction is minimal are best treated with primary re ection *because of the high incidence of carcinoma in diverticulitis* Hemorrhage which is usually evere and accompanied by shock can be treated con ervatively but the patient mu t be prepared for re ection when

Zinninger[1] stated that patients with chronic low grade obstruction and recurrent low grade inflammation should have the benefit of surgical excision This operation is in his opinion often more difficult than in cases of neoplasm since the mesentery is often thickened shortened and fibrotic and the ureter is drawn up into it necessitating accurate dissection of the ureter before any resection of the mesentery With acute infection or significant obstruction preliminary diverting colostomy is done before re ection is attempted and in acute perforation local drainage plu colo tomy should be performed to be followed by whatever surgical measures are appropriate Simultaneous presence of diverticula or diverticulitis and carcinoma is in this author s opinion reasonably common and differentiation often very difficult particularly when inflammation and at least ome degree of obstruction are present A diverting colostomy is usually a necessary preliminary operation and the time between colostomy and re ection is usually four to ix weeks with modern methods of surgery

Allen and Behringer reported on 210 con ecutive patient treated by resection since 1942 27 6 per cent of whom were admitted and operated on after their fir t attack of diverticulitis These authors stated that about two thirds of per ons aged 85 have diverticulosis and one third have diverticulitis sufficiently severe to warrant surgical treatment They also stated that it is their conviction that radical treatment i more logical in the young than in the old since one of the serious complications is more likely to develop during the longer life of the younger patient Furthermore in the younger age group before serious complications occur a one stage operation can be readily done Nearly all patients of any age however can be treated by resection if the definitive procedure is properly planned With long standing diverticulitis and chronic obstruction a well planned re ection at an elective time usually gives safe relief

Waugh and Walt[11] writing on changing concepts in the treatment of diverticulitis of the sigmoid stated that about 80 per cent of patients should be able to avoid operation for diverticulitis but when the disease *does not respond to medical measures a one*

stage operation can u ually be done in a quie cent period While a preliminary transver e colostomy will always be necessary in ome patients and in others a proximal colostomy at the time of anastomosis may be life saving colo tomy is no longer regarded as a routine concomitant of the surgical treatment of this di ea e The authors considered the main indications for elective operation today to be (1) intractability and recurrent episodes (2) subacute obstruction (3) walled off perforation which respond temporarily to antibiotics and non urgical treatment (4) unexplained melena with x ray evidence of diverticulitis (5) fi tula formation between sigmoid and other organs including kin (6) recurrent or per i tent urinary symptoms cau ed by the diverticuliti and (7) inability to diagno e nature of a palpable ma s (diverticulitis or carcinoma)

Maynard and Voorhees [0] wrote on a ca e of arterial hemorrhage from a large bowel diverticulum

1957

Keith and Rini [64] de cribed the significance of diverticula of the colon in ma sive melena They tated that clinicians and pathologists are reluctant to accept diverticula as the ource of hemorrhage becau e at autopsy a bleeding point may be difficult to find The incidence of diverticulosis of the colon is estimated at 5 to 10 per cent of adults over 40 years of age hence hemorrhage if due to diverticula should be a fairly frequent occurrence To attribute melena to diverticula however certain criteria hould be recog nized namely the bleeding hould be of bright red blood there should be no hemateme is all other sources of bleeding should be eliminated there hould be a negative upper ga trointe tinal x ray eries and blood coagulation hould be normal In the authors sur vey of 317 unselected patient with diverticula of the colon 60 (19 per cent) had mas ive hemorrhage gro s bleeding or tools re peatedly positive for occult blood by the guaiac te t Nineteen (6 per cent) had ma sive rectal bleeding and of thi group 13 patients had yncope or subjective symptoms of hock In all ca es con servative management with replacement of blood was u ed The authors advi ed again t emergency urgery in most ca e and in

many cases in which diverticula are distributed over most of the colon surgical resection is inadvisable because the specific bleeding site is seldom located However if the diverticula are limited to the *left colon resection should be feasible and when they are distributed* over the entire colon a transverse colostomy may suffice to afford relief of bleeding

Knight[66] wrote on massive hemorrhage from diverticular disease of the colon stating that hemorrhage as a complication of such disease of the colon is a fairly well accepted concept Not as well recognized however is the occurrence of massive exsanguinating hemorrhage as a complication of this disease This author reported from the literature a varying incidence of bleeding from 10 to 30 per cent usually of minimal amounts Knight reported two series of patients (1) 185 patients seen over a 10 year span with proved diagnosis of diverticulosis or diverticulitis and (2) 104 cases seen over a six year period also with proved diagnosis of diverticulosis or diverticulitis In group one 23 of the 185 patients (12 4 per cent) gave a history of gross bleeding from the rectum Adequate studies in all these cases showed no other cause for bleeding 7 of these 23 cases had evidence of marked blood loss requiring blood replacement In group two 33 (31 7 per cent) of the 104 patients gave a history of gross bleeding presumed to be from diverticular disease there being no other cause found and x ray evidence of diverticulosis present Of these patients 10 showed disease involving almost the entire colon *In 1* case proctoscopic examination disclosed bleeding from the mouth of a diverticulum in the sigmoid Of the 33 patients 7 suffered massive bleeding requiring blood replacement Of these 7 4 had diverticulosis of the entire colon and 3 showed diverticula from the hepatic flexure to the rectum The author drew several inferences from this study He considered massive bleeding a relatively rare occurrence considering the frequency of diverticulosis *He believed from his study that the severity of the* bleeding seemed to be correlated to the extent of the diverticular formation but he did not discount the possibility of hazardous bleeding from localized diverticulosis He also called attention to data observed in his study showing that massive hemorrhage seem more

likely to arise from diverticulosis rather than from diverticulitis and that infection is not essential for hemorrhage to occur No patients in this series had signs or symptoms of diverticulitis at the time of hemorrhage or a history of it in the past His thesis therefore is that local trauma produces ulceration with subsequent hemorrhage and is therefore the most important etiologic factor in hemorrhage from this disease Knight suggested conservative treatment at first that is rest sedation bowel management and blood replacement as indicated In most cases even in those with considerable bleeding he found this adequate An elective resection of the diseased bowel seem justified in localized diverticulosis when bleeding is recurrent or severe The challenge comes when massive bleeding does not stop and emergency laparotomy is required In such cases bleeding can be controlled by resection if the disease is localized If the disease is extensive involving the entire colon it is not always possible to localize the bleeding area resect it and do a subtotal resection of most of the bowel since an emergency operation for exsanguinating hemorrhage is a formidable procedure The author treated 2 patients of this type with diversion of the fecal stream by means of a colostomy and hemorrhage was thereby controlled He therefore suggested this procedure with a possible elective resection at a later time as the safest way to control massive hemorrhage from this cause

Strenger [1] felt that diverticulitis is a chronic progressive disease and advocated early surgical intervention before the onset of complications His criteria for selection of patients for surgery were as follows (1) a definite history of diverticulitis supported by physical findings in the lower quadrant of the abdomen (2) roentgenograms showing diverticula and persistent deformity and spasm of the sigmoid indicative of an inflammatory process (3) a specific history of more than one attack (4) rectal bleeding attributed to diverticulitis and (5) a good surgical risk

1958

Boles and Jordan [13] reported a study of 294 patients with diverticulosis whose history through an average follow up of 15 years (minimum of 10 years) was investigated for (1) increase in

number of diverticula (2) the development of diverticulitis in single or recurrent attacks and (3) development of complications bleeding obstruction perforation with or without fistula formation More extensive diverticulosis developed in about one half of the total group with one third finally having involvement of the entire colon Diverticulitis developed in 25 per cent (73 patients) Of this group over one half (40 patients) had no second attack (fol low up of three to 15 years) Of the 33 with multiple attacks about one half (16) had only two attacks The only complication of diverticulitis which appeared to be related to multiplicity of attacks was obstruction (9 out of 11 patients with obstruction having had multiple attacks) Melena or a brisk hemorrhage occurred in 18 of the total group (6 per cent) and of these 18 cases 9 had simple diverticulosis with no evidence of diverticulitis Of the total group 15 patients (5 per cent) had large bowel *obstruction* (2 with associated small bowel involvement) but only 11 of this group with obstruction had a clinical picture of diverticulitis Of the total group 15 (5 per cent) had perforation with or without fistula formation 10 of this group presented this complication during an acute attack of diverticulitis while in the other 5 cases perforations were slowly developing with mass or fistula formation In 15 (5 per cent) of the 294 patients with diverticulosis carcinoma appeared during the follow up period 8 (3 6 per cent) of these in the group of 221 patients who had had no attacks of diverticulitis In the 73 patients who had had diverticulitis carcinoma appeared in 7 (9 6 per cent) but 2 of these 7 patients had carcinoma in an area of the colon where no diverticula were present and 2 others had car cinomatous polyps of the sigmoid In only 3 patients (4 per cent) carcinoma appeared in the area of the colon where previous diver ticulitis had occurred

Horner wrote on 503 patients whom he followed 154 from six to 10 years and none less than one year in an attempt to elucidate facts on the natural history of the disease He believed that aging definitely plays a role in development but that previous *bowel habit* had no etiologic role However 83 per cent had an irritable colon prior to the development of the diverticula Approximately two

third showed no progression in the number of diverticula and 95 per cent had sigmoidal involvement The longer the follow up the better chance there was for the complication of diverticulitis to become manifest He believed that diverticulosis is a benign condition responding well to medical management Only 2 of the 85 patients with diverticulitis required surgical intervention and interestingly the complication of obstruction did not develop in any patient in this group

Schapira et al[93] recommended conservative and nonoperative treatment for diverticulitis of the cecum and right colon In their experience a second attack was quite rare They believed diverticula of the cecum and right colon are the same type as those in the left colon but usually they are fewer and more difficult to demonstrate especially during the acute phase

Degenshein[33] however believed that the diverticula of the right colon are pathologically distinct from those of the left in that they are true diverticula containing all coats The clinical diagnosis of diverticulitis is based on pain in the right lower quadrant with a mass and absence of nausea and vomiting He recommended for treatment the more radical approach of primary right hemicolectomy

Welch[113] noted the pattern of attacks of diverticulitis to be so variable that it was impossible to be dogmatic with regard to indications for surgery In the individual patients these considerations were important (1) other more malign symptoms present such as rectal bleeding or dysuria (2) roentgenographic studies showing serious deformity of the involved segment of the colon indicating that fibrosis and severe structural change will lead to obstruction at a later date (3) the attacks being persistent despite compliance with good medical advice and troublesome enough to require relief (4) those patients younger than 50 years representative of a group who will have the disease longer and who appear clinically to have a disproportionate number of serious complications and (5) the patient representing a good operative risk with a limited segment of colon involved with diverticulitis

He believed that the changing trend in the surgical treatment

of diverticulitis reveal a steady shift to the more radical and curative operations The 2 7 per cent mortality in 218 sigmoid resections at the Massachusetts General Hospital from 1912 to 1957 is impressive and their end results have been excellent The place of one stage segmental resection as a mode of relief from diverticulitis of the colon is recommended in the carefully selected patient

Jensen [61] stated that diverticula are the principal source of massive hemorrhage from the colon The anatomic basis for such hemorrhage is that the diverticula occur near the mesenteric border at the point at which the nutrient vessels penetrate the bowel There is also an unusual vascularity in the walls of the diverticula Some degree of erosion or inflammation must be present although no symptoms of such need be present Usually arteriosclerosis and hypertension are accompaniments Conservative treatment is recommended but if surgery is mandatory segmental resection of the most involved area is the procedure of choice

Scarborough [9] accumulated 89 patients with proven diagnoses of premalignant or malignant lesions who were observed for more than one year with a diagnosis of diverticulosis or diverticulitis as an accepted cause for their bleeding He advised exploratory operation and coloscopy when bleeding persists above the rectum and repeated roentgenograms show only diverticulosis

Colcock [10] noted from his analysis of 131 patients operated on during the past 10 years at the Lahey Clinic that in younger patients (less than 50 years of age) with recurrent attacks of diverticulitis complications necessitating surgical intervention were more likely to develop Often some degree of complication was present when the patient arrived at surgery such as a partial obstruction and small abscesses between the colon and bladder or lateral abdominal wall He found in this series that bleeding always responded to conservative management The mortality rate in this group was 1 5 per cent Of these patients 69 were subjected to a one stage resection with a primary anastomosis with no mortality He advocated earlier operation in those patients with relatively uncomplicated diverticulitis thereby lowering the mortality and shortening the hospital stay

1959

Schlicke and Logan[9] believed that surgery for diverticulitis is rare outside the sigmoid colon In their series approximately 10 per cent of the patients were not considered preoperatively to have diverticulitis The reasons for a faulty diagnosis were as follow (1) Diverticulitis frequently presents the clinical picture of gyneco logic disease or carcinoma of the intestine (2) when complicated by perforation diverticulitis may mimic diseases causing general peritonitis such as appendicitis (3) there may be an absence of any accompanying change in bowel habit (4) leukocytosis and fever may be absent (5) the presence of gross bleeding suggests diseases other than diverticulitis and (6) there is a discrepancy between the clinical picture of diverticulitis and the radiologic interpretation of diverticulosis without diverticulitis

The indications for surgery in order of frequency are (1) in tractability of symptoms (2) presence of palpable mass (3) in ability of the radiologist to exclude carcinoma (4) bleeding and (5) external fistula They advocated one stage resection and anas tomosis before serious complications develop necessitating multiple stage procedures

Earley[30] reviewed the literature and found reports of 24 patients who were operated on to control hemorrhage from diverticular disease Most of the patients were older than 60 years and most pa tients had operative procedures as emergencies Adding 7 patients of his own for a total of 31 patients brought the mortality to 29 per cent

He advised conservative management first which is often ade quate and then ruled out other causes for bleeding Even then the bleeding may not be attributed to the diverticula If diverticula are believed to be the source he then felt that one is compelled to resect all of the colon containing diverticula If the patient is too ill to tolerate resection or colectomy proximal ileostomy or colostomy may be helpful

Inglis and Hampton[9] favored the embryologic origin of the diverticulum in the cecum and ascending colon They believed it

is not always possible to distinguish diverticulitis in this location from acute appendicitis on a clinical basis but the suggestive triad described by Byrne Kallan and Bassett[17]—(1) hi tory of previou appendectomy (2) pre ence of a fecalith in the region of the cecum on x ray study and (3) symptoms of inflammatory disease in the right lower abdominal quadrant—is helpful At surgery 70 per cent of the diagnoses are correct and the remainder usually masquerade as carcinoma Colotomy or cecotomy often provides the diagnosis in the questionable cases They thought that major colonic resec tion can usually be avoided if diverticulitis is considered The treat ment of choice in this situation is local excision or simple inversion of the diverticulum

3 *Diverticulosis*

PATHOGENESIS

The first observations by Friend in 1730 by Baille in 1794 and later by Cruveilhier Konjetzny and Klebs established the entity of the lesion the diverticulum The subject then remained unnoticed in the literature at least until Graser in 1896 became interested in the pathogenesis having made the observation that the lesion was always found near the entrance of a blood vessel into the wall of the intestine and stating his belief that the herniation was associated with obstruction to the blood flow as in valvular heart disease About the same time Hanau [3] did some experimental work on human intestine at autopsy by filling the intestine with water and observing that rupture took place into the mesentery In 1904 Beer questioned the theory that the weak spot through which herniation occurred was always on the mesenteric side in fact he stated definitely that herniation occurred because of a muscular deficiency on the nonmesenteric as well as the mesenteric side and it was his belief that old age and constipation were the causes of herniation —old age by degeneration and constipation by intraluminal pressure In 1907 Mayo Wilson and Giffin added obesity to old age and constipation on the list of causes and left chronic passive congestion as a possibility In 1911 Wilson attributed the lesion to congenital weakness of the circumferential muscularis and to pressure from chronic constipation In 1954 Barborka and Texter stated their belief that neither obesity nor constipation plays a significant role in pathogenesis and again mentioned the fact that diverticula form where the intestinal wall is weakened by entry of blood vessels and that since the arteries of the mesentery divide into two branches and enter the intestine separately diverticula frequently occur in pairs at the edge of the lateral longitudinal bands However they stated that while degenerative changes of advancing age predispose to herniation the final impetus to diverticular formation is still unrecognized

is not always possible to distinguish diverticulitis in this location from acute appendicitis on a clinical basis but the suggestive triad described by Byrne Kallan and Bassett [17]—(1) history of previous appendectomy (2) presence of a fecalith in the region of the cecum on x ray study and (3) symptoms of inflammatory disease in the right lower abdominal quadrant—is helpful At surgery, 70 per cent of the diagnoses are correct and the remainder usually masquerade as carcinoma Colotomy or cecotomy often provides the diagnosis in the questionable cases They thought that major colonic resections can usually be avoided if diverticulitis is considered The treatment of choice in this situation is local excision or simple inversion of the diverticulum

with all layers caused by traction of tumors or adherent organs and the false produced by congenital weakness of the walls and excessive intraluminal pressure Hartwell and Cecil however in 1910 found no useful purpose in the classification of true and false or congenital and acquired and Wilkinson in 1933 stated that this classification had no clinical value Subsequent authors also seem willing to discard this classification

Authors Comments

With most writers of today the authors agree that the classification of true and false or congenital and acquired has only historical interest except in the case of so called traumatic diverticulitis of the cecum

INCIDENCE AGE AND SEX

In 1930 Rankin and Brown stated that diverticulosis occurred in about 5 per cent of persons having abdominal symptoms and probably in 1 per cent of all persons Ochsner and Bargen[83] in 1935 reported a 7 per cent incidence in 2 747 patients examined radiologically at the Mayo Clinic Young and Young in 1944 reporting on 70 572 colons studied by autopsy or with barium x ray examination gave the figure of 5 2 per cent for the incidence of diverticulosis

Authors Comments

It is impossible to estimate the incidence of diverticulosis with any degree of accuracy since usually the diagnosis is made roentgenologically and only a relatively small group of human beings have a barium enema examination or upper gastrointestinal series in which the passage of barium through the whole digestive tract is recorded by films Autopsy reports may be used as supplemental sources but in general are less dependable than roentgenograms for this diagnosis

It is interesting to note that Rankin and Brown s estimate of 5 per cent incidence of diverticulosis in patients with abdominal symptoms corresponds approximately with that of Young and Young in

Authors Comments

The authors agree with Barborka and Texter that there is as yet no proof of the *exact nature of the final impetus for the formation of diverticula* They also believe that since diverticulosis is in general a condition first discovered in middle or old age the degenerative processes alone or in combination with the cumulative insult of procedures abusive to the colon or of abnormal influences upon the colonic musculature from psyche or soma most probably play a part in the formation of these herniated sacs

Spasm the evil phenomenon at the root of many digestive complaints is undoubtedly present to produce the increased intraluminal pressure so generally agreed upon as a causative or precipitating factor If this word *spasm* is substituted for the word *constipation* a word meaning many things to many people the authors suggest that the two factors present in the formation of a diverticulum are probably degenerative changes with a possible congenital background * producing weakness or a gap in the muscularis together with an abnormal degree and frequency of spastic contractions producing intraluminal pressure Carlson and Hoelzel s investigative work on rats was of interest suggesting that fat infiltration weakened the bowel and that a diet which produced increased colonic pressure through continuous contraction caused diverticula The latter observation has special interest for the authors

TRUE AND FALSE DIVERTICULA

This distinction based on the finding of all layers of the intestinal wall in some cases and only the mucosa in others was of interest during earlier studies when the designation *true* was thought to be identical with *congenital* and *false* meant *acquired* Mayo in 1907 considered acquired diverticula to be either true or false depending upon the number of layers of the intestinal wall the true variety

* The theory of a congenital background is supported as frequently stated in the literature by the fact that diverticulosis does occasionally occur in the young Interesting also in this regard is Schlotthauer s report of 7 cases in one family of 9 persons and the clinical observation made by the author and others that familial diverticulosis is frequently seen



aged 85 have diverticulosis This statement conforms with the impression of the authors

Also it has come to be the opinion of most observers today that the sex incidence is about equal and the authors agree with that opinion Hence based on estimate only 5 per cent of all individuals but 15 to 40 per cent of those over 40 have diverticulosis while in the really aged the intestinal muscularis apparently becomes weak enough to allow the development of diverticula in varying extent (FIGURES 1 and 2) in about two thirds of the population

a large uncla sified group When the specific age group of indi viduals over 40 is considered the estimated incidence in the litera ture rises as high as 15 per cent to 10 per cent (see Johnson s Fig 276 in Bockus Gastroenterology on age distribution from Millard and Bockus 1936) and this incidence increases with each decade Allen and Behringer (1956) stated that about two thirds of persons

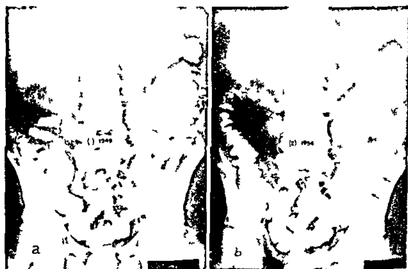




Fig 1 —Development of diverticula in patient with irritable colon *a* 1949 *b* 1951 and *c* 1958

Fig 2 (facing page)—Development of diverticula in patient with irritable colon *a* 1932 *b* 1936 *c* 1940 and *d* 1943



F g 4—Di erticul i of sigmoid w th an a soc ated g ant di ertic lum

clinically interesting but harmle s condition called by Ca e *diverticulosis*

In 1927 Spriggs and Marxer [29] and in 1951 Barborka and Texter mentioned the aw-edge appearance of the sigmoid as indicating a prediverticular state and the fact that diverticulosis is often best visualized in the po tevacuation film

Authors Comments

In the authors experience colonic diverticula are best vi ualized in the po tevacuation barium enema film or in a film taken 24 hours

DIAGNOSIS

X ray Study

It is generally agreed that diverticulosis cannot even be suspected clinically until the complication of inflammation and its sequelae occur In 1915 however Case and Carman reported separately the early x ray observation of this condition Following their report all radiologists looked for and found what they considered a



Fig 3—Extensive diverticulosis demonstrated after evacuation of barium

diverticulitis stating that actually seeing the diverticula is possible more often than is usually believed In 1951 Smith added another diagnostic point to Buie s statement with his observation that displacement of the fecal content of the sac under slight pressure from the distal tip of the sigmoidoscope helps to diagnose and localize diverticulosis

Authors Comments

In the experience of the authors and their colleagues the openings of the diverticular sacs are very rarely seen by proctosigmoidoscopy Other signs are present when there is an inflammation or other complications These will be discussed later

TREATMENT

Authors Comments

Most writers on the subject of diverticular disease regard treatment of the diverticula as entirely unnecessary until complications initiated by inflammation occur They consider all diverticula of the digestive tract from the esophagus to the anus as innocuous unless inflammation is present

In the authors opinion this is usually true of diverticula of the upper digestive tract but in the colon where strong sometimes violent muscular contractions occur it is wise to use prophylactic treatment against the occurrence of diverticulitis The authors theory is that inflammation is usually initiated by the blocking of the openings into the diverticula by extreme and sustained muscular spasm so common in the irritable colon It is therefore their belief that when symptoms of irritable colon are present and diverticula are visualized anywhere in the colon the patient should be advised that their presence is an additional reason for care of the irritable colon Further discussion on this point will follow under the section on diverticulitis

after the barium meal (FIGURES 3 and 4) The differentiation between polyps of the sigmoid and diverticula in that area sometimes becomes a problem and here lateral films postevacuation films and double contrast films are of help in differentiating diverticula from polyps (FIGURE 5) An inverted diverticulum protruding into the lumen of the intestine may strongly simulate a polyp



Fig 5—Diverticulosis of sigmoid demonstrated after an air contrast study

The authors urge that in all reports of barium enema examinations the presence and location of diverticula should be reported as well as an estimate of their size and number Such reports have importance not only for evaluation of the patient's present or possible future abdominal symptoms but also in aiding statistical research studies

Proctoscopy

Buie in 1939 and Jackman and Buie in 1943 reported diagnostic signs by proctoscopy which aroused suspicion of diverticulosis or

tioned the tendency to recurrent attacks and the chronic inflamma tory changes in the whole inte tinal wall and its me entery obstruc tion resulting from the e factors or from adhesions In 1930 Rankin and Brown considered diverticulitis to be the result of improper emptying of the bottle shaped acculations with sub equent inflam matory reaction necrosis frequent tumefaction and occasional per foration They described the local inflammatory changes in the mucous membrane of the diverticulum which undergoes atrophy and subsequent round cell infiltration of the submucosal coat and lateral ulceration The e changes progress both in the wall of the bowel and in the me entery producing a pericolitis and mesenteritis The changes in the coats of the diverticulum vary from attenuation of the musculature to its complete absence

Authors Comments

To the descriptions of the pathogenesis of diverticulitis cited above little new has been added in the last quarter of a century The authors would like however to emphasize again the role of spasm in the development of inflammation in the diverticula Mor ton in 1946 in his 196 reported ca es divided them into two groups diverticulitis with spa m and diverticulitis with complications He together with Wilkinson in 1933 and Albright and Leonard in 1951 in their recommendations for treatment indicated that pasm plays an important role in the development of diverticulitis and that measures to relieve spasm and restore normal motility in the intes tine are the best treatment for uncomplicated diverticulitis The author s theory of the development of diverticulit is that it is an advanced stage in the whole problem of pathogenesis of diverticulo sis The sacs have already been formed and with normal contrac tions of the bowel mu cularis there is an inflow and outflow of fecal material which then passes on with the re t of the bowel contents If however spasm in that area is excessive there is a tight closure of the diverticular openings and the phenomena of retained fecal material inflammation necrosis and ulceration may occur More will be said on this subject when treatment of diverticulitis is discussed

4 *Diverticulitis*

PATHOGENESIS

Moynihan in 1906 called attention to inflammatory tumors many of which were quite possibly due to the presence of false diverticula and associated inflammation He was the first to point out a diagnostic difficulty which perplexes clinicians of today namely the mimicry by these tumors of malignant disease of the large intestine Mayo in 1907 considered the true variety to be due usually to traction caused by adherent tumors or organs while the false were thought to be due to intraluminal pressure combined with a congenital weakness of the bowel The e inflamed diverticula might arise in his opinion from any surface and often extended into the epiploical appendages He considered constipation with hardened feces impacted in the diverticulum as the cause for beginning irritation and ulceration He thought old age and obesity were factors and he mentioned chronic passive congestion as a possible factor He considered the inflammatory process either diverticulitis or peridiverticulitis the former causing no great reduction in the size of the bowel lumen but having a tendency to acute perforation into the peritoneal cavity Peridiverticulitis on the other hand by producing chronic inflammation of the subserosa around the diverticula he considered more prone to cause obstruction and rarely to perforate because the reparative process was so predominant

Telling in 1908 considered the pathologic factors of diverticulitis to be multiple and to include the narrow neck of the diverticulum collections of fecal matter within the diverticula constipation increased intraluminal pressure and obesity Hartwell and Cecil in 1910 considered the secondary changes occurring in diverticulitis to be comparable to those in the vermiform appendix in appendicitis the inflammatory process causing destruction of the coats of the wall with perforation leading into a localized abscess generalized peritonitis or septicemia They were among the first to describe fistula formation especially into the urinary bladder They also men

to find out what happened to the diverticula in 294 patients (average age at time of diagnosis 55 years) over a course of years after they were diagnosed as simple diverticula. It was revealed that in 73 patients (25 per cent) diverticulitis developed but in 40 of these (more than 50 per cent) there was no second attack in a follow up period varying from one to 27 years. 19 of these 73 had follow up study for 11 to 27 years. In 33 of this 73 (45 per cent) multiple attacks occurred but of these 33, 16 patients (slightly less than half) had only two attacks in a follow up of one to six years after the second attack while 17 patients (slightly more than half of this group with more than one attack and approximately 6 per cent of the total 294 patients) had more than two attacks of diverticulitis. This group under observation was also under management for irritable colon and although the control of mismanagement was not recorded the significance of these statistics (25 per cent having at least one attack of diverticulitis in a follow up of 15 years average) is probably greater than in any study without follow up. Of equal significance is the fact that under these conditions only 6 per cent of the total group had more than one attack during this follow up period.

DIAGNOSIS

The symptoms related to diverticula are caused by spasm and inflammatory change which indicate that diverticulitis has occurred. The severity of the symptoms depends on the degree of involvement and the location of the inflammatory process. Pain is the cardinal symptom. It is usually located in the left lower quadrant of the abdomen and reflects involvement of the lower descending or sigmoid colon where the majority of diverticula occur. Depending on the degree of spasm and inflammation or the development of complications the pain may be of a dull aching character or more severe as occurs with acute appendicitis. Colic or cramp-like pain suggests severe spasm or some degree of obstruction. Constipation or tenesmus and diarrhea associated with anorexia, nausea and vomiting may be expected in severe acute attacks.

INCIDENCE

Mayo in 1917 10 years after his first paper on ' acquired diverticulitis reported 42 cases in which operation had been performed 37 of which involved the sigmoid 1 the transverse colon 1 the ascending colon 1 the hepatic flexure and cecum Later writers began to estimate the percentage of diverticulitis among all patients with diverticulosis Rankin and Brown in 1930 stated that of the 5 per cent of patients with abdominal symptoms who had diverticulosis *17 per cent* had diverticulitis In 1944 Young and Young from a compilation of statistics comprising 70 572 colons (x ray and autopsy cases) in which 5 per cent had diverticulosis 12 to 15 per cent of these had diverticulitis In three series of their compilation however totaling 3 915 cases of diverticulosis the incidence of diverticulitis was *34 3 per cent* Wigh and Swenson in their paper in 1951 dealing with the roentgenologic aspects of diverticulitis and its complications stated that of the generally accepted 5 to 10 per cent incidence of diverticulosis diverticulitis developed in *12 to 22 per cent* Barborka and Texter (1954) stated that in their experience 5 to 10 per cent of all patients have diverticula and of this group diverticulitis develops in *15 to 20 per cent* Greene[31] in 1957 found 50 7 per cent diverticulitis in a review of 353 cases of diverticulosis The highest incidence of diverticulitis was reported by Allen and Behringer in 1956 in their paper on this condition in the very aged They stated that two thirds of persons aged 85 have diverticulosis and of this group one third have diverticulitis In the group of cases of diverticulosis studied for subsequent developments by Boles and Jordan diverticulitis developed in *73 of 294 patients (25 per cent) with diverticulosis at some time during a period of* 10 to 17 years

Authors Comments

As with statistics on all diseases there can be considerable confusion because of the variety of sources from which information is obtained In the paper by Boles and Jordan the specific purpose was

regional ileitis ulcerative colitis carcinoma bacillary and amebic dysentery and pelvic pathologic alterations in the female Boles and Hodes[1] in describing a group of cases with endometriosis *involving the small and large intestine and rectum* recently showed how the disease can mimic diverticulitis in its varying forms

Roentgen examination of the colon by means of the barium enema usually indicates the presence of diverticulitis both by revealing certain fairly specific changes and by eliminating other conditions mentioned in the differential diagnosis (FIGURES 6 7 and 8)



F g 7 – Di rt cul tis of igmoid w th part al ob truction and intra tal le symptom



Fig 6 —Uncomplicated di erticuliti of sigmoid

On physical examination the abdomen is frequently distended and tympanitic Definite localized tenderne s is noted over the site of the inflammatory proce s and either a painful segment of bowel or an inflammatory mass will usually be palpable On occasion the inflamed egment of bowel is more easily defined by pelvic or rectal examination Some degree of fever u ually is pre ent

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Fi 7 —D rt ul s s of sigmoid with partial ob truct on and intractable symptom



Fig 6 —Uncomplicated diverticulitis of sigmoid

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In the differential diagnosis one must consider acute appendicitis

Schatzki[94] stressed the following roentgenologic findings which he believes are of assistance in the diagnosis of diverticulitis (1) a long segment of bowel often involved (2) mucosa remaining intact (3) bizarre fringed contour (4) associated spasm (5) tapered ends of the involved bowel and (6) accompanying diverticula in other segments of the bowel In the absence of diverticulitis 24 and



Fig 8—Diverticulitis of sigmoid

48 hour examination of the bowel following barium meal will reveal the presence of diverticula more clearly than will a barium enema

Proctoscopy is of invaluable assistance in the *differential* diagnosis of diverticulitis Following are five signs previously mentioned and emphasized by Buie[15] (1) relative immobility of the bowel in a segment which normally is freely movable (2) angulation of the lumen of *the bowel* (3) *reduced lumen and mucosal fold* (4) sigmoidal sacculations distinguished from spastic contracture of the bowel in that they do not disappear with inflation and (5) actual visualization of the diverticula more frequently seen with

diverticulosis than with diverticulitis He cautioned that the rare everted diverticulum which can strongly resemble a polyp should be identified If such an error is made and fulguration is attempted perforation is an unfortunate sequela

Authors Comments

In the majority of patients the exact precipitating cause of acute diverticulitis cannot be determined Specific inquiry however will frequently reveal that fatigue sustained nervous tension dietary or alcoholic excesses and indiscretion or an upper respiratory infection have usually preceded an attack The frequent indiscriminate use of laxatives in preparation for diagnostic studies or in bowel preparation for a proctoscopy or barium enema is an avoidable contributing factor in converting a quiescent colon with diverticula into diverticulitis

Not infrequently patients with an irritable colon and diverticulosis who are suffering an aggravation of their symptoms are classified as having an attack of diverticulitis without any of the accompanying features found by physical examination laboratory findings or roentgenologic study Errors in over diagnosis or under diagnosis are made in this group and can lead to mismanagement and to unfortunate variations in statistical reporting

In radiographic study during an acute attack particularly when a small segment of bowel or perhaps only a single diverticulum is involved in the inflammatory process diverticula may not be visualized and spasm may be the only finding

We have seldom received significant assistance from examination —grossly or microscopically—of the actual rectal discharge or stool When blood or pus is seen our search is intensified to rule out carcinoma

Attempts to demonstrate tumor cells by means of cytologic examinations of the specimens from the bowel with the techniques now recommended in acutely ill patients have been found to be neither practical nor dependable

COMPLICATIONS

Carcinoma and Diverticulitis

The first complicating aspect of diverticulitis mentioned in the literature is one which for the clinician of today is still a perplexing problem It was mentioned by Moynihan in 1906 in the 6 ca es which he reported as having inflammatory tumors of the large intestine presenting all the clinical appearances of cancer which proved on pathologic examination to have been wrongly diagno ed Gra er also described this problem in 1899 In 1910 it was suggested by Hartwell and Cecil that a carcinoma superimposed upon diverticulitis might develop and in 1911 Wil on propo ed that low grade proliferative changes took place in the tips of the diverticula to form segregated epithelium parallel in all respects with cell changes which occur in masses of epithelium segregated about the base of a gastric ulcer From this development the entire diverticulum became involved the walls infiltrated with a hi tologic picture which mu t be diagnosed as carcinoma A year later (1912) McGrath stated that cancer was associated with diverticulitis in 25 per cent of his series of cases Case in 1915 mentioned the difficulty in differentiating diverticulitis from carcinoma In 1917 Mayo stated that carcinoma coexisted in 13 (31 per cent) of 42 patients with diverticulitis upon whom he had operated He considered this more than mere coincidence and was of the opinion that chronic irritation and inflammation led eventually to a cancerous change In 1924 however Judd and Pollock while tating that the relation hip of carcinoma to diverticulitis was not determined noted that Mayo s evidence taken from a study of 137 ca es suggested that there was no relationship between the two conditions The e authors were the first to sugge t that the relation hip between diverticulitis and carcinoma was coincidental In 1930 Rankin and Brown in a review of 227 ca es had only 4 cases in which malignant di ea e was associated with diverticuliti and in 679 ca es of carcinoma of the colon only 4 ca es of diverticulo is were present Wilkinson in 1933 mentioned the difficulty of differentiating the two conditions both clinically and roentgenologically Morton in 1946 in his eries of 196

cases stated that 17 patients had carcinoma associated with diverticulosis but called attention to the important fact that in only 4 of these patients the carcinoma was in the area of the colon involved by diverticulitis In 1951 Wigh and Swenson in their paper on radiologic aspects of diverticular disease stated that evidence of spasm and edema was rarer in carcinoma than in diverticulitis In 1952 Rowe and Kollmar in discussing diverticulitis complicated by carcinoma stated that obstruction and anemia are more suggestive of carcinoma whereas evidence of inflammation a palpable mass and fistula formation are more frequent with diverticulitis They quoted statistics from several hospitals showing that in 700 patients with carcinoma of the colon only 7 had coexisting diverticulitis and carcinoma and of these only 3 patients (0 43 per cent) had diverticulitis and carcinoma in the same segment Starkloff and Bindbeutal mentioned in 1953 that the symptoms and signs of carcinoma and diverticulitis mimicked each other and also coexisted with symptoms suggesting only one entity In their review of 259 patients with carcinoma of the bowel and 30 patients with diverticulitis 25 had coexisting carcinoma and diverticulosis 6 had coexisting carcinoma and diverticulitis but again the point was made that only 4 of these had carcinoma and diverticulitis of the same segment the rectosigmoid an incidence of 1 5 per cent suggesting that the relationship was coincidental Twenty five patients had carcinoma and diverticulosis of the same segment the rectosigmoid They believed bleeding and cachexia should arouse suspicion of carcinoma and in their series bleeding was present in 62 per cent of carcinoma and 19 per cent of diverticulitis The best differential x ray sign for carcinoma was in their opinion a normal appearance of the colon above and below the malignant growth but this sign also had pitfalls They emphasized the need for a more aggressive surgical approach to the treatment of all patients in whom cancer is strongly suspected In 1954 Hoar and Bernhard stated that in 385 cases diagnosed as diverticulitis or diverticulosis only 14 patients (3 6 per cent) had carcinoma present in an area where diverticula were present and of 466 cases of carcinoma of the colon and rectum 38 (8 per cent) had a concomitant diagnosis of diver

ticulosis which they stated was the expected figure in the middle aged or older population as a whole In 1954 Barborka and Texter stated that coexistence of carcinoma of the colon and diverticulitis was relatively rare that cachexia and rectal bleeding were more common in carcinoma while recurrent attacks of pain in the left lower quadrant fever constipation and urinary symptoms were more common in diverticulitis Ransom in 1954 found that in operating on 53 patients with diverticulitis carcinoma was coexistent in 7 In 1956 Mayo and Delaney reviewed 50 patients (35 males and 15 females) from the ages of 41 to 82 who had diverticulitis and carcinoma of the colon simultaneously and who had had surgical treatment In 38 cases (76 per cent) the preoperative diagnosis or impression had been correctly surmised

Boles and Jordan in 1958 found 15 patients (5 per cent) of the 294 patients with diverticulosis who had cancer of the colon Of the 221 patients with no progression to diverticulitis cancer developed in 8 (3 6 per cent) Of the 73 patients in whom diverticulitis developed during their observation period cancer developed in 7 (9 6 per cent) This apparently significant relationship however was invalidated by the fact that in 2 of those 7 patients cancer developed in an area uninvolved by diverticulitis and in 2 others the carcinomas were in polyps which were detected in a period when there was no active diverticulitis This leaves only 3 cases or 4 per cent of the patients with diverticulitis in whom there could possibly be a presumptive relationship

Authors Comments

From the year 1954 on emphasis was placed by several writers on the necessity for surgery in all cases in which carcinoma could not be ruled out but the impression persists that this is not always feasible A persistent mass or an x ray deformity is usually the equivocal point

There is no question but that a mass or x ray deformity of any segment of the colon must be viewed with grave suspicion of cancer and the problem of early differential diagnosis of carcinoma from diverticular disease is more difficult because diverticulitis occurs

most often in that period of life when carcinoma is likewise most frequently found When the lesion is in the left lower quadrant where both carcinoma and diverticulitis are so often found the differential diagnosis is especially difficult because of the immobility of the mass and its inaccessibility to sigmoidoscopic examination

In these days when surgery is relatively safe it is imprudent to wait for cachexia to arouse suspicion Dependence must therefore be placed to some degree upon the history to a large degree upon x ray findings and to a very minor degree upon statistics indicating the coexistence of diverticulitis and carcinoma and the possibility of considering diverticulitis as a precursor of carcinoma As has been so often said in the literature a history of recurrent attacks of pain in the left lower quadrant usually with fever and leukocytosis and the findings of x ray evidence of diverticula are the diagnostic criteria for diverticulitis When the lumen of the bowel is narrowed as shown by x ray findings and there is clinical evidence of obstruction and if a mass is palpable carcinoma is suspected and cannot be definitely ruled out without surgical resection and histologic examination There are however factors which influence one's judgment in one direction or another Statistical evidence has seemed to disprove Wilson's theory that the epithelial proliferative changes of diverticulitis lead to carcinoma It must therefore be a question of deciding whether or not the lesion in question is carcinoma coexistent with diverticulitis or simple diverticulitis The precachectic evidence suspicious for carcinoma has been thought by many writers to be both bleeding and x ray signs but in the opinion of the authors x ray findings alone are the only suggestive evidence The complication of bleeding will be discussed separately but its occurrence in diverticulosis and diverticulitis is a definite entity and is not necessarily a reason for suspecting carcinoma The x ray evidence consists of the following factors—an area of narrowed lumen with obliterated mucosal pattern and shelflike superior and inferior borders separating normal bowel from the involved area (FIGURE 9) This is in contrast to a more gradual change from normal bowel to the inflamed segment of diverticulitis in which perhaps edematous

but otherwise normal mucosa can be visualized It must always be recognized however, that the signs of cancer can be obscured by the deformities produced by the presence of multiple diverticula and of diverticulitis With persistent or increasing stenosis uninfluenced by a short period of conservative management the diagnosis must usually be determined by resection and then the only problem for the surgeon is the decision as to the extent of the resection



Fig 9 — Carcinoma of sigmoid with associated diverticula

Without obvious signs of carcinoma this decision must be made on biopsy and frozen section examination and an appropriate operation performed

Bleeding

In the earlier days of studies of diverticular disease there was considerable reluctance to the acceptance of bleeding as a symptom of diverticulosis or diverticulitis without an associated polyp or malignant condition However Rankin and Brown in 1930 stated that when bleeding occurs as a symptom of uncomplicated diverticu

litis or diverticulosis an associated malignant condition is always suspected but frequently not found

For some years now the concept has been well established that hemorrhage may be an outstanding and often perplexing symptom of both diverticulosis and diverticulitis While this is true anal bleeding without hemateme is still remains a problem worthy of special consideration

The frequent difficulty in identifying the source of such bleeding is emphasized throughout the literature and the exhortation prevails that before assuming that such bleeding has its source in a diverticulum all other areas in the gastrointestinal tract be carefully examined by procto igmoidoscopy radiologic examination study of clotting mechanisms and liver function studies Almo t all writers on this subject have urged that careful search must be made for hemorrhoids ulcerative colitis polyps and carcinoma

The incidence of bleeding in diverticular disease has been variously e timated as from 5 to 8 per cent in diverticulosis and from 15 to 25 per cent in diverticulitis Smithwick[98] in 1942 reported bleeding in 15 7 per cent of 568 cases of diverticulitis from the Massachusetts General Hospital and the literature Young and Young in 1944 estimated that bleeding usually minor had been thought to occur in 5 to 17 per cent of diverticulitis and was more often found in the chronic than in the acute phase of this disease

Judd and Mears in 1955 found an incidence of hemorrhage of 8 5 per cent in a series of 68 cases of diverticuliti Bell[11] in 1953 reported that in 68 patients with diverticulosis or diverticulitis which required operation 50 per cent had blood in the stools but of these 68 patients 28 per cent had carcinoma and 10 per cent colonic polyps Knight in 1957 reported 12 4 per cent of gross bleeding in 185 patients with diverticulosis or diverticulitis and considered it to be more frequently found in diverticulosis than in diverticulitis Boles and Jordan in 1958 found in their follow up study of 294 cases that during the years of observation (average 15 years) under more or less trict treatment 16 patients (5 4 per cent) had bleeding and of these 16 patients 7 had diverticuliti

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But the strong suspicion of cancer when bleeding is present has persisted as is evidenced by the paper of Gilchrist and Economou in 1955 who advocated operation for diverticulitis when bleeding occurs because it must then be assumed that polyps or carcinoma are also present In 1956 Waugh and Walt while claiming that in about four fifths of patients with diverticulitis surgery could be avoided if medical management were employed stated that otherwise unexplained melena with x ray evidence of diverticulitis is one of the indications for surgery Repeated bleeding had also been mentioned by Swinton in 1951 as an indication for surgical intervention In fact this type of continued even if intermittent blood loss when otherwise unexplained and if persistent under medical management has become an accepted indication for resection of the area where diverticula are visualized even though carcinoma is not seriously suspected When no doubt of cancer exists in the diagnosis Mobley Dockerty and Waugh[74] in 1957 reporting on 31 patients who had had surgical treatment for diverticulitis associated with bleeding stated that conservative treatment was possible in many instances

Keith and Rini in 1957 mentioned the reluctance of clinicians and pathologists to accept diverticula as a source of hemorrhage because a bleeding point may be difficult to find at autopsy Pfeiffer[86] in 1944 in a discussion of a paper by Stone[101] on melena of unknown origin explained the absence of external evidence of the site of bleeding from a diverticulum on the basis of the contiguous location of the diverticulum to the artery which feeds the epiploic appendage

While bleeding from diverticular disease is generally reported as minor bleeding usually intermittently observed the occurrence of massive hemorrhage from diverticular disease has also been reported in recent years Hickey in 1954 reported a case of massive exsanguinating bleeding in a 65 year old man in whom surgery revealed a perforation of an area of sigmoid diverticulitis which had involved the left inferior epigastric artery with a fistulous tract

carrying the blood into the colon Al o in 1954 Hoar and Bernhard reported 4 ca es of massive hemorrhage in patients with diverticular disea e In certain of such ca es it may become necessary to explore urgically even without completed investigation of the source of bleeding The surgeon may then be confronted with a colon filled with blood and with numerous diverticula cattered throughout the extent of the bowel While some of this blood may be the result of backflow from a di tal area it cannot be assumed that the source of bleeding is in the sigmoid especially ince ca es of massive hemor rhage from diverticula in other areas have also been reported A case of multiple diverticula of the cecum and colon with clotted blood in numerous diverticula at emergency operation was reported by Cate [3] in 1953 Hoar and Bernhard reported 2 patients with diverticulitis who presented the problem of uncontrolled rectal hemorrhage requiring exploration as a lifesaving measure and 4 other patients with diverticular di ease with massive hemorrhage 3 of whom died Knight in 1957 reported massive bleeding from extensive diverticulosis and in 1 case the ource of bleeding from the mouth of a diverticulum was seen on procto copic examination Mobley Dockerty and Waugh reported a patient with diverticulitis in whom death from myocardial infarction followed two weeks after massive rectal bleeding

Authors Comments

The reluctance of earlier writers to accept bleeding as a symptom of uncomplicated diverticulosi or diverticulitis has been changed by experience to a recognition that this symptom may occur with both the e conditions Bleeding is usually of minor degree and inter mittent but massive hemorrhage has al o been reported often enough to establi h it as a po sible occurrence in this disease Minor hemorrhage is usually described by the patient as bright blood on the surface of the tool and mucus may or may not be seen mixed with the blood From the fir t reporting of bleeding as a symptom of diverticular di ease up to the pre ent great emphasis has been placed in the literature on the need for careful examination of the anal canal rectum and sigmoid for the pre ence of hemor

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toms Patter on[64, 65] noted in hi study of 131 ca es of diverticulitis that infection of the pelvic colon is well tolerated and many of the patients consulted their physicians only after the fulminant signs of generalized peritonitis appeared

The first report of a perforated diverticulum with diffu e peri tonitis was made from an autopsy described by Fiedler[44] in 1868 In recent years there have been frequent reports of unusual



Fig 10—Di erticulitis of sigmo d w th local zed perforation.

cases often in sigmoid diverticulitis but occasionally in diverticulitis of other areas of the colon for example in the report of cecal diverticulitis by Case and Shea in 1953

Morton in 1946 reported 39 perforations in 111 cases of diver ti ulitis 3 of which were free into the peritoneal cavity the other 36 forming a localized abscess Of the e patient 10 died while in the hospital Fi tula developed in 22 cases and more than one region was involved in 11 cases—11 to the kin 8 to the bladder 2 to the urethra 2 to the small inte tine 1 to the cecum 2 to the rectum 4 to the vagina 1 to the retroperitoneal tissue 1 forming an ischiorectal sinus and 1 into the me ocolon Kraemer and Siegel[67]

rhoids polyps or carcinoma Physicians today are keenly aware of this need for thorough investigation The detection of sigmoid polyps in the presence of diverticulosis is often difficult even with air contrast enemas lateral projections are helpful in differentiating polyps from diverticula although rarely a diverticulum inverted into the lumen of the bowel may be mistaken for a polyp

Carcinoma must always be suspected when rectal bleeding occur but in the absence of sigmoidoscopic and x ray findings positive for cancer polyps or other intestinal lesions diverticula if present may properly be suspected The most recent trend of thought and one which conforms also with the authors experience is that bleeding usually minimal but occasionally massive may occur from diverticula without the presence of inflammation and infection which produces diverticulitis Perhaps the most innocent type of bleeding is the intermittent type while that due to carcinoma or polyp is usually persistent in spite of treatment Apparently the intermittent bleeding caused by diverticula has its source in an erosion within the diverticulum which may heal with conservative treatment

Bleeding which is persistent in spite of treatment is one of the indications for surgical treatment first because of the effect of blood loss and second because under these conditions an ulcerative carcinoma cannot be satisfactorily ruled out in spite of negative examinations The importance of repeated examinations is as great in this disease as in suspected cancer elsewhere in the digestive tract

Perforation and Fistula

Perforation and fistula formation are the two most hazardous complications of diverticulitis Peridiverticulitis with or without abscess formation or generalized peritonitis is usually present when perforation occurs (FIGURES 10 and 11) Abscesses may be small and entirely peridiverticular or larger and encapsulated in the mesentery

Peridiverticulitis usually causes stenosis of the bowel lumen and in such cases differentiation from carcinoma may be impossible even at operation Perforation may be acute and symptomatically of sudden onset or develop slowly with gradually progressive symp-

urinary symptoms indicating the presence of the severe complication of colovesical fistula

The colovesical fistula is of course relatively common because of the anatomical proximity of bladder and sigmoid (FIGURE 12) It may be diagnosed either by the barium enema examination or by cystoscopy In a recent case seen by the authors the diagnosis was made by the cystoscopic finding of a piece of lettuce in the bladder

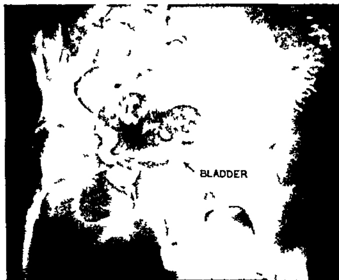


Fig 12—Diverticulitis of sigmoid with formation of a fistula to bladder

of a woman who complained of bladder symptoms In all cases but especially in males when urinary symptoms occur with an attack of diverticulitis a colovesical fistula should be seriously considered

Mayo and Blunt [73] in 1950 reported an incidence of vesicosigmoidal fistulas in 46 (22.8 per cent) of 202 cases of proved diverticulitis of the large intestine The sex incidence was 39 males and 7 females the explanation was offered again that the interposition of the uterus between bladder and sigmoid usually protects the female from this complication Urgency and frequency were noted by them also as the chief symptom and many of their cases

in 1918 reported a case of diverticulitis of the ascending colon with perforation abscess formation and fistulization into loops of the ileum

These problems of perforation and fi tula formation involving surgery became less common with the advent of the antibiotic era as was noted by Friesen and Schmidt in 1955 the chief surgical problem now being a stenosing obstruction It is still true however that often the symptom of which the patient is fir t aware are

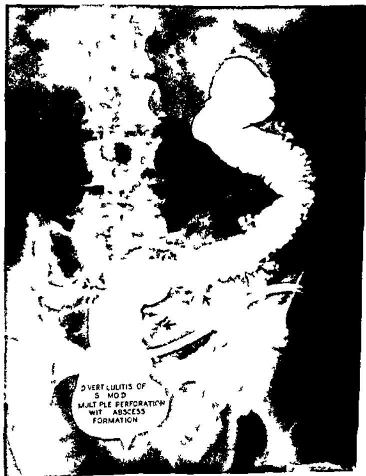


Fig 11 —Di erticulitis of sigmoid Mult ple perfo ations with ab ce s format on

which surgical drainage is required In recent years diffuse peritonitis rarely occurs from an acute perforation

Urgency and frequency of urination often occur in cases of diverticulosis and the irritable colon syndrome and these symptoms *per se* do not indicate an impending or actual vesicocolic fistula although they are suggestive Fecaluria and pneumaturia are pathognomic

When this complication occurs a multiple stage procedure is required frequently with a greater mortality and morbidity which offers a rational argument for earlier operation in those patients who have recurrent attacks of diverticulitis at relatively short intervals In the series of 69 patients of Colcock undergoing one stage procedures however some patients had a small vesicocolic fistula and others had localized perforations with small abscesses and a primary anastomosis was carried out with very little additional risk

Obstruction

The complication of obstruction is usually the result of previous attacks of acute or subacute diverticulitis with progressive involvement of the bowel wall

Mayo et al in 1907 believed that peridiverticulitis with inflammation of the submucosa around the diverticula reduced the lumen of the bowel with resultant obstruction In 1917 Mayo warned of the difficulty in distinguishing those patients with obstructive diverticulitis from carcinoma—the former often having a long history of symptoms of diverticulitis Carcinoma not infrequently became manifest with a complete obstruction

Morton in 1946 discussed 34 patients with diverticulitis with obstruction and related the significance of the history of repeated infections scarring and thickening of the colon causing partial obstruction Other possible causes for obstruction were adhesions about an abscess and the adherence of the small intestine to an area of colonic diverticulitis

In 1951 Wigh and Swenson estimated that in two thirds of the patients with diverticulitis the symptoms were based on some degree of obstruction They mentioned the practical point that with a

had been treated for urinary infection since there had been few symptoms suggestive of intestinal disease Pneumaturia was present in 10 of the 46 patients and 14 complained of suprapubic or perineal pain Of the 46 patients 21 had passed feces from the urethra and 10 had hematuria The authors ascribed pain to inflammation and engorgement of the fistulous tract with the solid material of the feces *Gross hematuria was late in appearance and thought to be* caused by trauma from fecal material and cystitis The procedures used by these authors were as follows (1) proctoscopy and sigmoidoscopy which showed changes suggestive of a fistula in only 3 of 38 patients (2) barium enema examination which showed the fistula in 9 of the 45 patients thus examined, and (3) cystoscopy which revealed evidence of a fistulous opening in the bladder in 28 of 33 patients The e authors experience with the use of organic dyes administered orally or rectally or instilled into the bladder to detect a fistulous communication was often misleading

Authors Comments

The complication of perforation and fistula in our experience is frequently associated with recurrent attacks of diverticulitis and predisposes to surgical intervention *In the paper by Boles and* Jordan this complication occurred in 5 per cent of 294 patients who had follow up studies for an average of 15 years With multiple attacks of diverticulitis the incidence of this complication increased because of a smoldering of the inflammatory process and the presence of small abscesses with incorporation of the adjacent tissue The stage is thus set for fistula formation into the small intestine bladder vagina uterus rectum and perianal region and skin It is sometimes difficult to determine whether a localized perforation with abscess formation has taken place with the masking of symptoms by the dampening effect of the surrounding structures walling off the perforation and the oftentimes rapid response to conservative management and antibiotics Uncomplicated acute diverticulitis can mimic a small perforation in every respect Although this complication occurs *frequently* it is impossible to know the number of cases in which spontaneous resolution occurs as again t the number in



Fg 11—Aden carcinoma of gmoid

ob truction to be infrequent in patients who had only one attack of diverticulitis but it was the most frequent complication when multiple attacks occurred and required surgery in 8 of 11 patients (73 per cent) The acute form in our experience i less common and it is more difficult to identify the cau e preoperatively because of the inability to study the patient as carefully roentgeno graphically In the patient who re ponds to con ervative manage

barium enema spasm produces a picture of a more severe grade of obstruction than is demonstrated when the barium passed distally Hickey in 1951 believed that obstruction was the most common complication of diverticulitis which is the experience of most students of this disease in the more current literature

Authors Comments

With multiple attacks of diverticulitis obstruction in some form becomes the most frequently observed complication and is an outstanding indication for surgical intervention The authors found

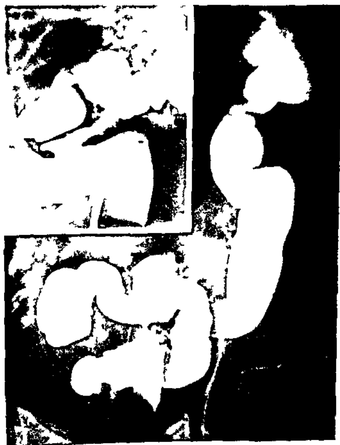


Fig 13—Diverticulitis of sigmoid with intractable symptom

The ever present challenge of differentiating the pathologic proc ess from carcinoma is most dramatically portrayed here and the surgeon often cannot make this differentiation with any degree of certainty by gross inspection of the intact bowel (FIGURES 13 14 and 15) The bowel wall adjacent tissue and mesentery are in volved with the chronic inflammatory hyperpla tic proce s which to the inspecting finger is a thickened hard mass with marked nar rowing of the lumen

When the specimen is inspected soon after removal the normalcy of the mucosa is striking in contra t to the far advanced pathologic changes of the extraluminar ti ue

Whereas a multiple stage procedure with colostomy preceding re ection may be indicated in cases of acute obstruction chronic obstruction can u ually be managed safely with segmental resection and primary end to-end anastomosis

MEDICAL TREATMENT

In ca es of acute apparently uncomplicated diverticulitis the first and paramount principle is to put the bowel at rest If possible the patient hould be hospitalized Bed rest and a low residue warm bland diet are es ential The application of heat to the abdomen administration of hot water by mouth and anti pasmodics (such as some form of atropine) in moderate tolerated doses provided the patient does not have glaucoma and mild edation complete the initial phase Paregoric or deodorized tincture of opium may be required to alleviate troublesome spasm and diarrhea If the patient is afebrile and the acute symptoms subside in the first 24 hours antibiotics are seldom indicated With persi tence of a low grade fever leukocytosi and clinical evidence of continued activity sulfasuxidine azulfidine (amino azo ulfapyridine) or neomycin rather than the broad spectrum antibiotics will be found helpful As a matter of fact azulfidine often will be useful as a prophylactic in warding off a threatened acute attack In the presence of vomiting penicillin and streptomycin may be indicated as well as the parenteral u e of fluids for 24 to 48 hours The majority of patients will respond to these measures without sub equent complica

ment with or without decompression of the bowel definitive study can then be carried out for diagnosis Chronic obstruction resulting from diverticulitis with or without acute symptoms is due to the inflammatory process with edema, induration fibrosis and narrowing of the lumen Adhesions may involve the small intestine producing elements of both small and large bowel obstruction Angulation by adhesions and inflammation may be most significant in contributing to the irreversibility of the clinical and pathologic picture



Fig 15 —Diverticulitis of sigmoid with narrowing and partial obstruction

development of chronic diverticulitis or complications requiring surgical intervention may be averted

When attacks recur or complications such as perforation fistula formation obstruction or hemorrhage develop surgical intervention becomes necessary The trend is toward earlier surgery but the decision requires the utmost in clinical judgment and often the indications are not clear cut We would include as an indication for surgery the intractable form of clinical diverticulitis manifested by frequent recurrences despite good medical management

Palliative treatment in those patients without complications however is still strongly supported by the authors The opinion expressed that radical treatment is more logical in the young than in the old since one of the serious complications is more likely to develop during the longer life of the younger patient is not supported by the authors because it does not consider the possibility that diverticula are especially common later in life Furthermore in younger individual diverticula are quite likely to occur at some future time in other areas of the bowel in which case further surgical intervention might be required

In our experience the diagnosis of carcinoma is seldom as confusing as the literature indicates Roentgenograms after a suitable period of intensive medical hospital management stool examination for occult blood and the utilization of the patient's clinical gastrointestinal history lend many helpful hints A preoperative diagnosis of diverticulitis with hemorrhage has rarely been an indication for surgery In such cases distinguishing the condition from carcinoma becomes more pressing

When surgical intervention is indicated segmental resection is preferred because of the low mortality rate and the favorable long range prognosis

Colcock[30] stressed the fact that inadequate surgery is responsible for many of the complications associated with the surgical treatment of diverticulitis Welch[114] emphasized the need of discretion in the selection of patients for the one-stage procedure and as a safety factor preliminary to the operation he pointed out the value

tions or chronicity developing The diet is then increased permitting only those foods that are easily digestible The following program of management for an irritable colon and diverticulosis is then instituted

The treatment of the irritable colon is also based on the principle of physiologic rest Hypermotility of the small intestine and spasm of the colon respond to the various measures conducive to rest For those patients in whom the symptoms persist under ambulatory dietary control or for those who are convalescing from an attack of diverticulitis absolute bed rest is recommended Heat (hot water bottle electric pad or flaxseed poultice) is applied to the abdomen for one hour two or three times daily The diet consists at first of the most easily digested bland foods served in six feedings during the day as the patient becomes asymptomatic the variety is increased to include meat cooked vegetables and fruit and the meal frequency is returned to the conventional pattern with the heavy meal preferably at noon No ice cold food or drink is permitted and supplementary hot water is given between feedings at regular intervals Excluded from the diet are pork and pork products veal and boiled meats also excluded are raw vegetables and fruits Food from the frying pan or cooked in deep fat and accessory foods such as nuts candies olives and pickles are forbidden

Laxatives and *lubricants are to be avoided at all times The use* of orange or prune juice diluted with equal parts of hot water before breakfast and for some patients before each meal is often an adequate stimulus for bowel function rectal injection of 3 ounces of warm mineral oil at bedtime or as an emergency procedure a saline enema may be permitted

Smoking even when not excessive is in the opinion of the authors conducive to spasm of the colon Alcohol may be used before the evening meal in the form of 1 ounce of whiskey diluted with 3 to 4 ounces of water without ice Cocktails and dry wines are often troublesome Adequate daily rest exercise and regular vacations are encouraged to balance the patient s work schedule In this way recurrent attacks of acute diverticulitis may be pre*vented and the*

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of a protecting colostomy Buie[15] likewise cautioned that in the more serious and complicated cases a preliminary colostomy should be performed

Whenever possible the operative procedure should be performed after the acute attack has subsided This is desirable both from the standpoint of morbidity and to permit a more direct and simple *surgical approach*

In the study of any patient with a history of diverticulitis or during the acute attack a search should be made for coexistent disease which may influence the prognosis with regard to subse *quent attacks In our* experience gallstones and peptic ulcer occur with sufficient frequency so that they should be considered and if present actively treated When gallstones are present cholecystec tomy is indicated after the acute attack of diverticulitis has subsided

Prognosis

The prognosis for patients with uncomplicated diverticulitis on a bowel management program is quite good In the authors experience with 73 patients who had had diverticulitis more than one half (40 patients) had only one attack during a follow up period of one to 27 years In 19 of these the follow up period was 11 to 27 years As would be expected multiple attacks of diverticulitis were associated with more than twice as many complications as were single attacks 21 of the 33 patients who had been having multiple attacks were free of attacks during a follow up period of three to 10 years which can be partially attributed to the fact they had adhered to their program of bowel management

Depending on the type of complication and the surgical procedure used the prognosis may be extremely variable In well selected pa tients however who receive adequate surgery the prognosis should be quite favorable Following operation the patient is strongly ad vised to adhere indefinitely to the modified bowel management previously outlined in order to remain in a symptom free state

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